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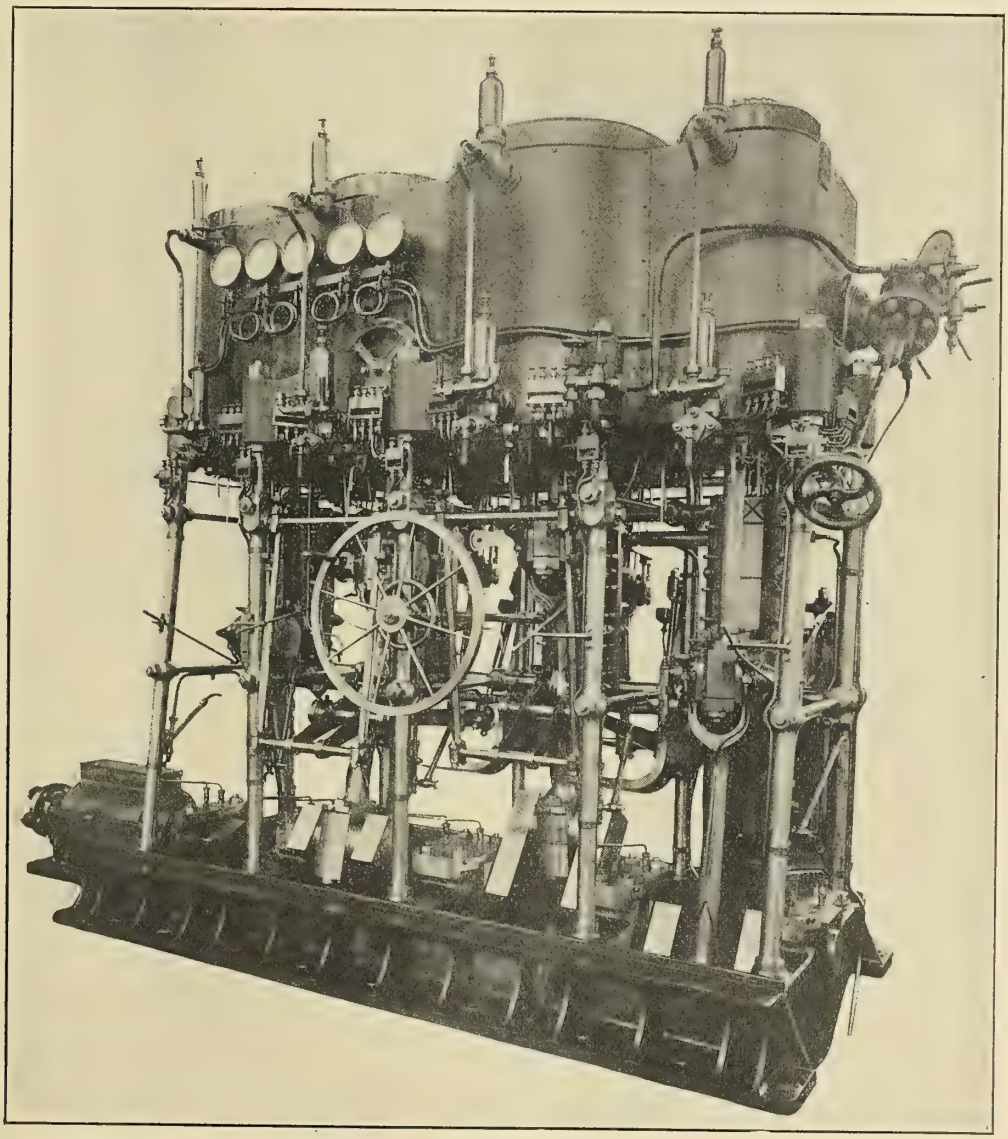
JAPANESE IMPERIAL YACHT HATSUKAZE.

The steam yacht *Hatsukaze* was built, furnished and engined by Messrs. Mitsu Bishi Dockyard and Engine Works, Nagasaki, Japan, to the order of Baron Iwasaki, the owner of the establishment, and presented to his Imperial Highness, the Crown Prince, as a souvenir of his Highness visit to the works in 1900.



FRONT VIEW OF QUADRUPLE EXPANSION 230 I. H. P. ENGINE FOR JAPANESE IMPERIAL YACHT HATSUKAZE.

The vessel is built on the composite principle, although a departure is made in the construction from the general rule, the framing of the vessel being of wood, except in the way of saloon, where the frames are of angle steel, galvanized. The center girder, which extends from the stem head to the extreme end of stern, is built of steel plates and angles, the floors, which are also of steel, are riveted to this girder. The

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bulkheads, stringers, tie-plates, cabin sole, and beams are of steel, as also boiler and engine seats and coal bunkers. All steel and iron work is galvanized throughout.

In many respects she is unique and her appointment and equipment are very complete; her principal dimensions are as follows:

Length over all	109 ft. 0 in.
Length between perpendiculars	90 ft. 0 in.
Breadth	18 ft. 0 in.
Depth	10 ft. 1 1-2 in.
Draft	6 ft. 6 in.
Tonnage	121 tons.

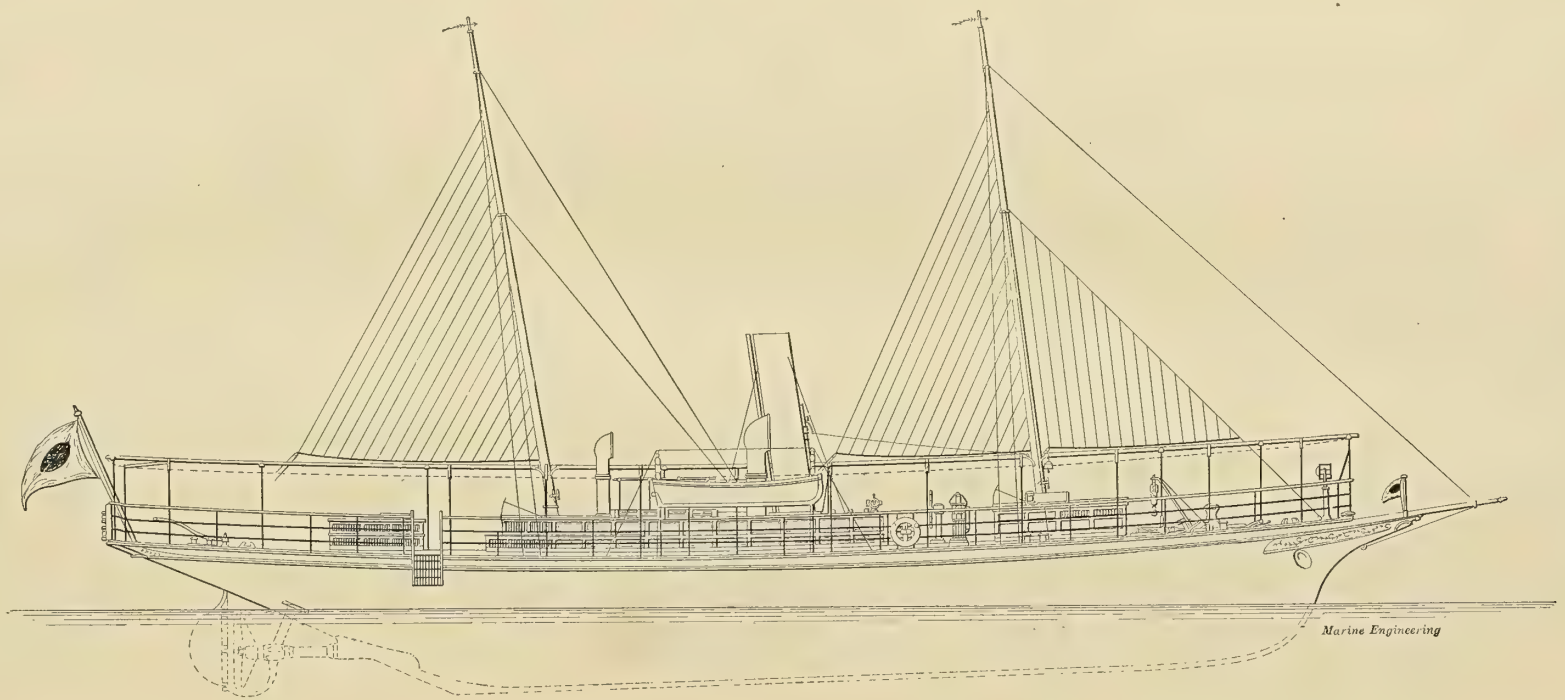
The hull and deck planking is of selected teak wood throughout and all fastenings are of copper and yellow metal.

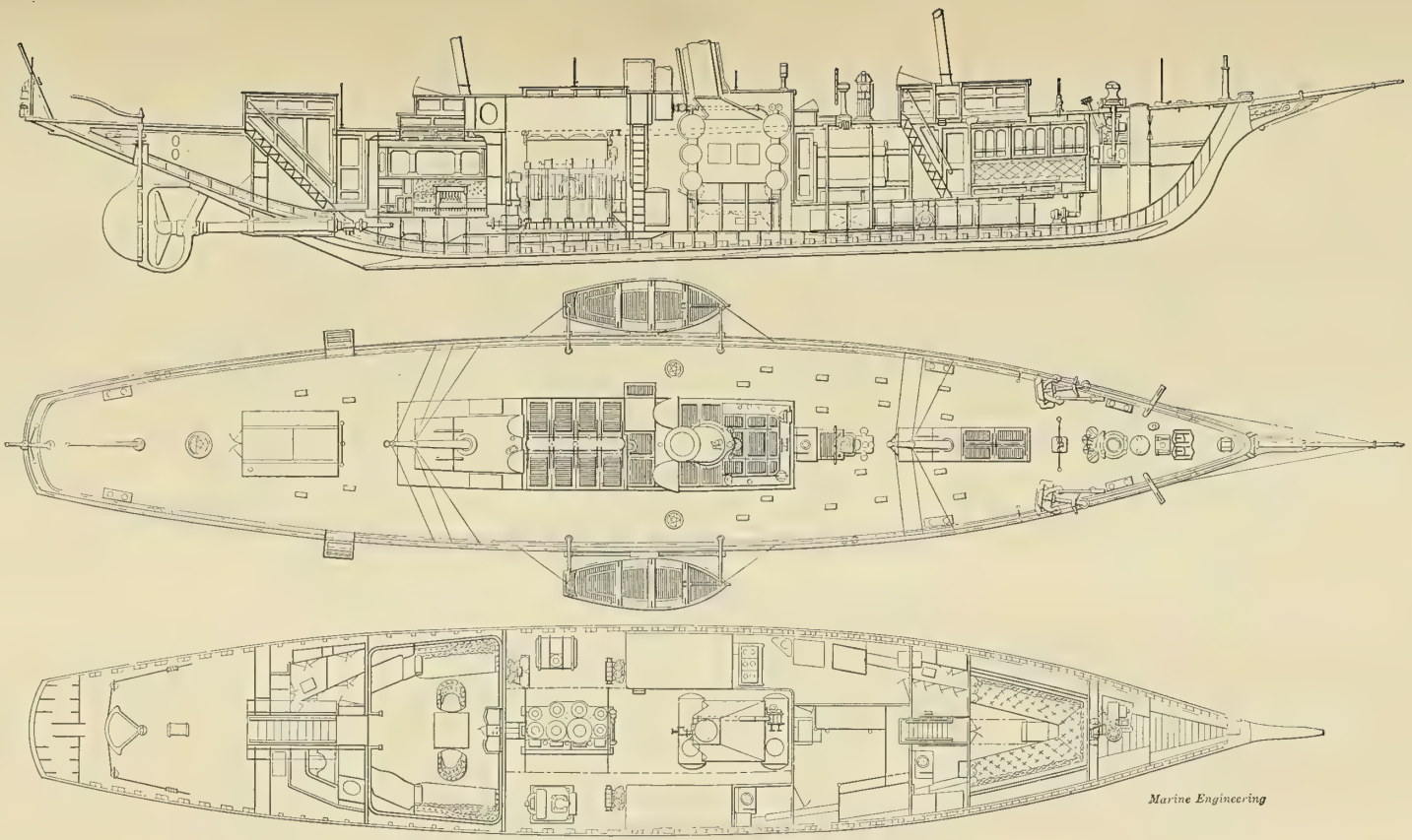
The vessel has four water-tight bulkheads. She is of graceful form, having a long, overhanging bow, with carved head and hanging rails, square stern, one funnel, and two masts. She is flush decked, and engine and boiler casings, companions, etc., are kept flush with the level of the rail. The dead wood aft is entirely cut away, the stern tube being fitted into a gun-metal casting, which is connected to the steel center-girder, the stern-post, which is of gun-metal, is of unique design; the rudder is also of gun-metal, being a solid casting. All deck fittings, such as capstan, steering gear, bollards, fairleads, rail stanchions, etc., are of gun-metal.

Situated immediately abaft of the engine room is the prince's saloon, adjoining which are toilet rooms and pantry. Forward of the boiler space is accommodation for the prince's suite and the crew, also a galley, pantry and toilet rooms.

Baron Iwasaki's particular desire when placing the order for the craft was that care should be taken to make her as comfortable and luxurious as possible, regardless of expense, and if possible, beyond criticism; and when it is considered that this is the first yacht of any pretensions to be built in this country and the difficulties to be encountered in furnishing such a craft, it may well be conceded that the builders have faithfully carried out the baron's desire.

The fittings and decorations of the saloon are of the finest character throughout. The sides of the saloon are finished in a framing of native tochi wood, beautiful in itself, with its frosty-grain on satin-like surface, and panel mounting of cloisonne ware.





ELEVATIONS AND DECK PLANS OF THE IMPERIAL JAPANESE COMPOSITE STEAM YACHT HATSUKAZE.

There are fourteen cloisonne panels worked in the saloon, two of which are 36 inches wide and the others about 18 inches in width. The designs of these panels are as follows: Cherry blossoms, iris and swallows, wistaria and dove, futami (famous native semi-marine scenery), in large panel; peony, stork and willow, wood-lily, poppy, holly-hocks and wild duck, chrysanthemums, Fuji mountain, in large panel; quail, bamboo and cocks, and camellia in snow. These to be arranged from right hand side of entrance, in order, round the saloon, and are specially designed by Mr. Tsunoya, many of whose works are familiar in the Imperial Palace, and who was specially requested to bring the chrysanthemums and wistaria into the design. Whilst the former needs no explanation, the latter represents the crest of her Highness, the Princess, before marriage.

The ceiling is in enamel white and gold. The skylight over the saloon is exceptionally large and so arranged that the whole top-flat can be lifted up, thus making it specially suitable for a warm climate. This, together with saloon companion, is to be glazed with crystal-cut-glass, expressly cut and prepared to the builder's design.

The saloon is furnished with chiffonier, what-not, small writing desk, and table of the same wood as the side frame-work, all of elaborate and dainty design, yet not overdone. The upholstery is of uncut morone silk velvet with flora-paullonia design with table-covers and door curtains to match. The velvet is specially woven and prepared by Mr. Iida to the builder's design. The

floor is richly carpeted with axminster carpet, also with one set of tenzen (wild silk-worm) carpet woven to size in one piece.

The most striking part of the saloon above all is the metal-fittings such as drawer, door handles and pulls, bell-push-covers, candle-lamps, etc.; they are designed and worked by Mr. Susuki, of Tokyo, a member of the Imperial household artisans, and the designs are combinations of snow, moon and flowers, three idols of Japanaese poetical subjects. They are made of gold, silver and other valuable metals.

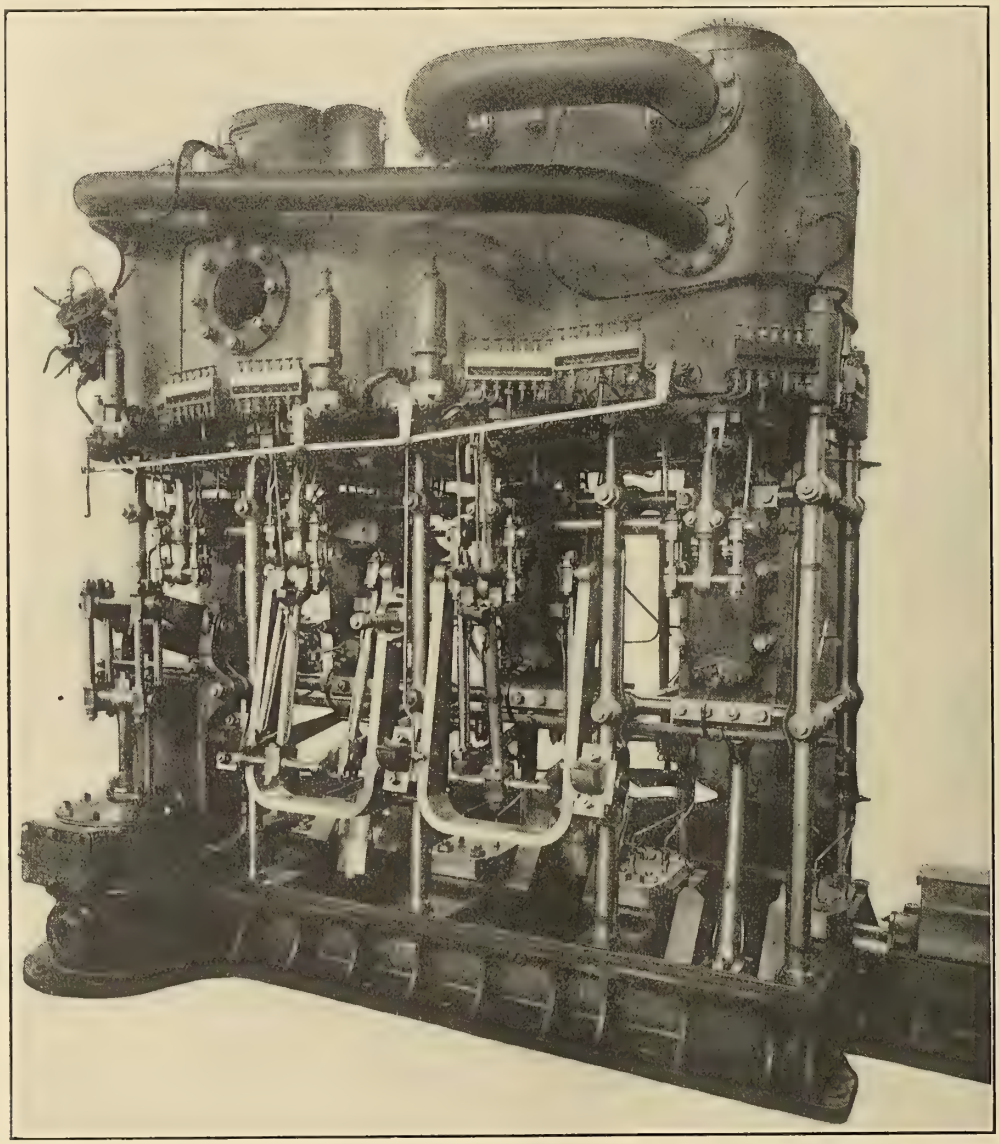
The toilet room is paneled enamel white, picked with gold. The mirror is fitted in a carved frame, and the lavoratory has a marble top and tip-up basin. The marble is from Yamaguchi-Ken, the southern province of the main-island. The toilet room is to be also fitted with under-waterline closet.

The pantry is paneled similar to toilet room, but one could hardly fail to notice the difference of its design from ordinary ship pantries, for most of the exposed parts are made portable and all the lockers are fitted with inner cases, so that they may be easily removed and cleaned.

The sides of the suite's room are paneled with tochi wood in teak framework. The sofa is covered with dark green morocco leather and the curtains are of Kyoto silk damask of similar color.

The floor is carpeted with brussels carpet, also of dark green. The toilet room is fitted with patent fold-up lavatory in oak-case and under-waterline closet. In general respect, the finish and style will be similar to cabins of first class passenger steamers.

All metal fittings in suite's room, pantry and lavatory are electro silver-plated and the floors of pantries, toilet rooms, and passages are covered with India-rubber mats of special design.

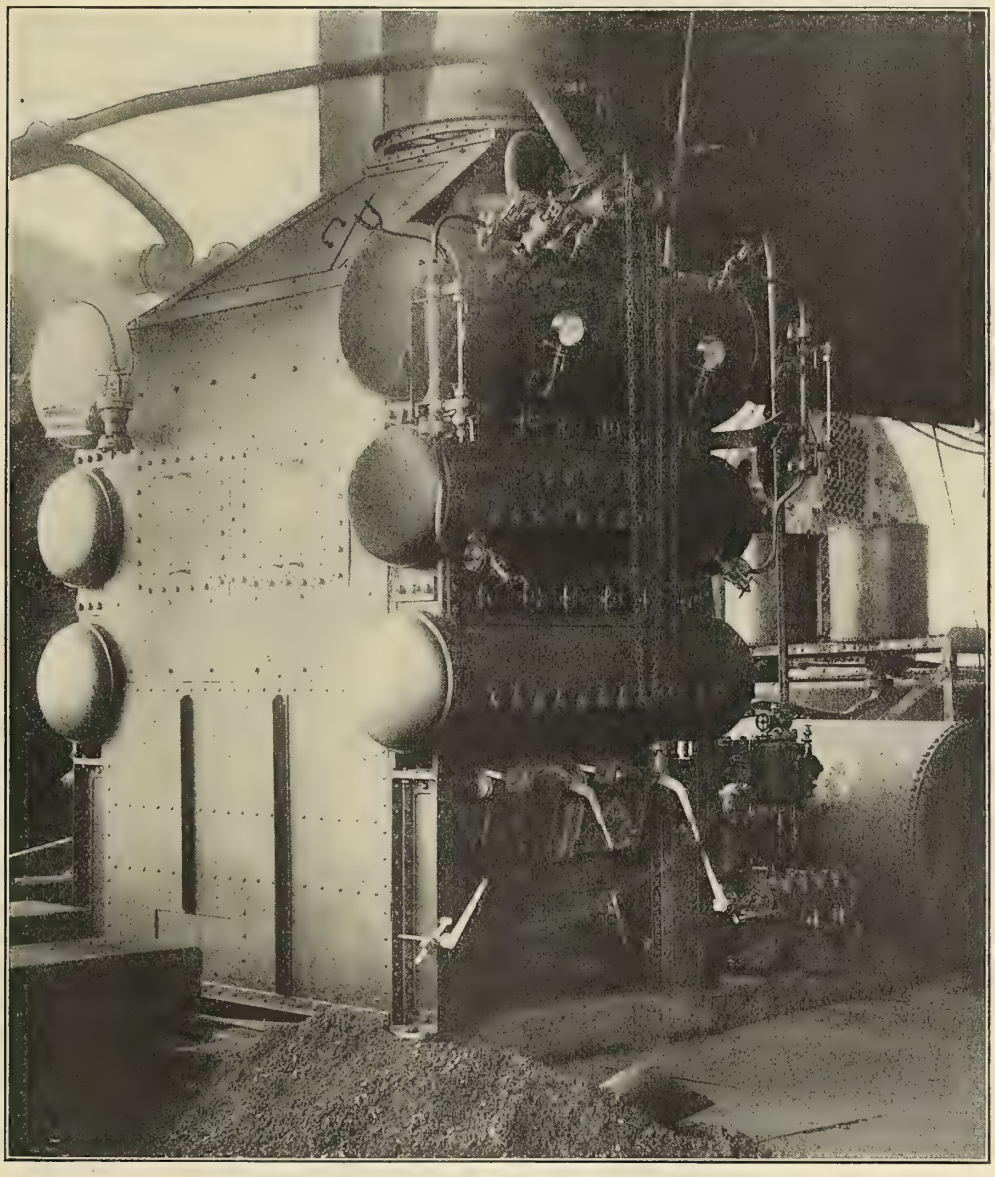


REAR VIEW OF QUADRUPLE EXPANSION ENGINE FOR THE STEAM YACHT HATSUKAZE—JOY VALVE GEAR.

The ventilation arrangement is of most approved description, every attention being taken to suit the climate. This is carried out by four Sturtevant monogram-exhausters. Two are placed aft, for supplying and exhausting the aft-compartment and the remaining two forward for fore-compartment. The supply pipes are so arranged that they may pass through the heated chambers, so as to supply warm air to the compartment in cold weather.

The yacht is fitted with Lord Kelvin's standard compass, with nickel-plated binnacle, electric capstan windlass, and steering gear, both of the builder's design and make, and Chudburn's reply engine room telegraph on nickel plated stand with dials in Japanese characters. In addition, not to depend solely upon speaking tubes in case of temporary derangement of the telegraph, and further to facilitate the working of the yacht, she is to be fitted with Graham's patent ship-telephone to engine room.

There are two small boats, built of mahogany and polished, carried one on each side, and in the vicinity of the boats the yacht is fitted with two Archibald patent life-buoy detaching gears with polished copper life-buoys.



WATER-TUBE BOILER FITTED IN THE STEAM YACHT HATSUKAZE.

A complete electric lighting and power plant is installed. The generating plant consists of one set of General Electric single engine dynamo. A small search-light is also fitted.

MACHINERY.

The main propelling machinery consists of a set of four-crank quadruple expansion engines of the usual inverted marine type, each cylinder driving a separate crank and balanced on the Mitsu-Bishi balancing system,

which is claimed to have proven a distinct success in many steamers built and engined by the firm.

The diameter of the high-pressure cylinder is 7 3-4 inches, of the first intermediate cylinder 10 3-4 inches, of the second intermediate cylinder 15 inches, and of the low-pressure cylinder 21 inches. The stroke is of 18 inches. The arrangement of cylinders forward and aft is: high pressure, low pressure, 2d intermediate, 1st intermediate. The high pressure and first intermediate cylinders and also all piston valve casing are fitted with liners.

Each valve is of piston type and placed diametrically at the back of each cylinder, and high pressure and the first intermediate pressure piston valves will take steam at inside and others at outside. The valve gear employed is of Joy's radial gear type. The air pump is driven by levers off the cross-head of the high pressure engine and is of Edward's patent.

The cylinders, liners, covers and sole-plate are all of cast iron and the columns of polished forged steel. The main bearings, "ahead" thrust shoes, and blocks are all lined with white metal. All the shafting is of forged steel. The propeller is four-bladed, made of navy-bronze. The condenser is separate from the main engines, placed longitudinally fore and aft, and of cast brass, the door and end which take the inlet and branches are also of brass castings. The total cooling surface is 265 square feet. Two efficient duplex pumps are fitted to complete the pumping system of the yacht.

Steam at a pressure of 220 pounds per square inch is supplied by Dr. Miyabara's patent water tube boiler. The general design of boiler consists of two water walls forming the front and back of a combustion chamber, each composed of three horizontal steel drums, arranged one above another, and connected together by short vertical tubes, the upper drums being steam chambers. A series of diagonal steam generating tubes connects the drums of the two walls and cross each other over the fire-grate. Within the two middle drums and enclosing the ends of the two groups of generating tubes which meet therein, diaphragm boxes are fitted for the purpose of separating the up-cast water rising through the generating tubes, from the down-cast water, running down from the top steam drums to the bottom water drum. These diaphragm boxes are of sufficiently short lengths and fitted in a simple manner so that they can easily be removed and replaced if required without interfering with any other part of the boiler. The back steam drum is connected to the front one by means of a steam pipe running through the up-take. The feed water is introduced in the back steam drum into an open box. There is a communicating pipe connecting the two bottom water drums in order to keep the same level of the water within the two water walls, and a suitable mud or sediment collector is fitted on this pipe at the lowest part of the boiler.

The area of the fire grate surface is 21.875 square feet, the length of fire bars being 5.5 feet and the total tube heating surface is 780 square feet.

On her trial she attained a speed of 12.43 knots. Externally she presents a very pleasing appearance, with her graceful sheer and fine finish, and is unquestionably the prettiest craft that has ever graced Eastern waters.

YAMACHO.

12,726-MILE RUN OF THE NEBRASKAN BURNING OIL.

A most remarkable run with oil as fuel was completed on March 26, when the American-Hawaiian steamship *Nebraskan* arrived in New York from San Diego, Cal., steaming all the way with oil as fuel. The distance covered was 12,726 nautical miles, and the steaming time 51 days 7 hours 26 minutes, an average speed of 10.35 knots. Only twice during this run was the throttle closed, and both of these times happened in the Strait of Magellan, once for anchoring because of the tide, and the second time at Puntas Arenas to telegraph her owners. Both of these stops amounted to 21 hours 37 minutes, which to obtain the total time for passage is to be added to the steaming time. On the trip 8,826 barrels of Bakersfield (Cal.) residium oil were burned, which weighs 336 pounds per barrel, making 1324.7 long tons for the voyage. The trip was most successful in point of speed, absence of delays and regularity of steaming.

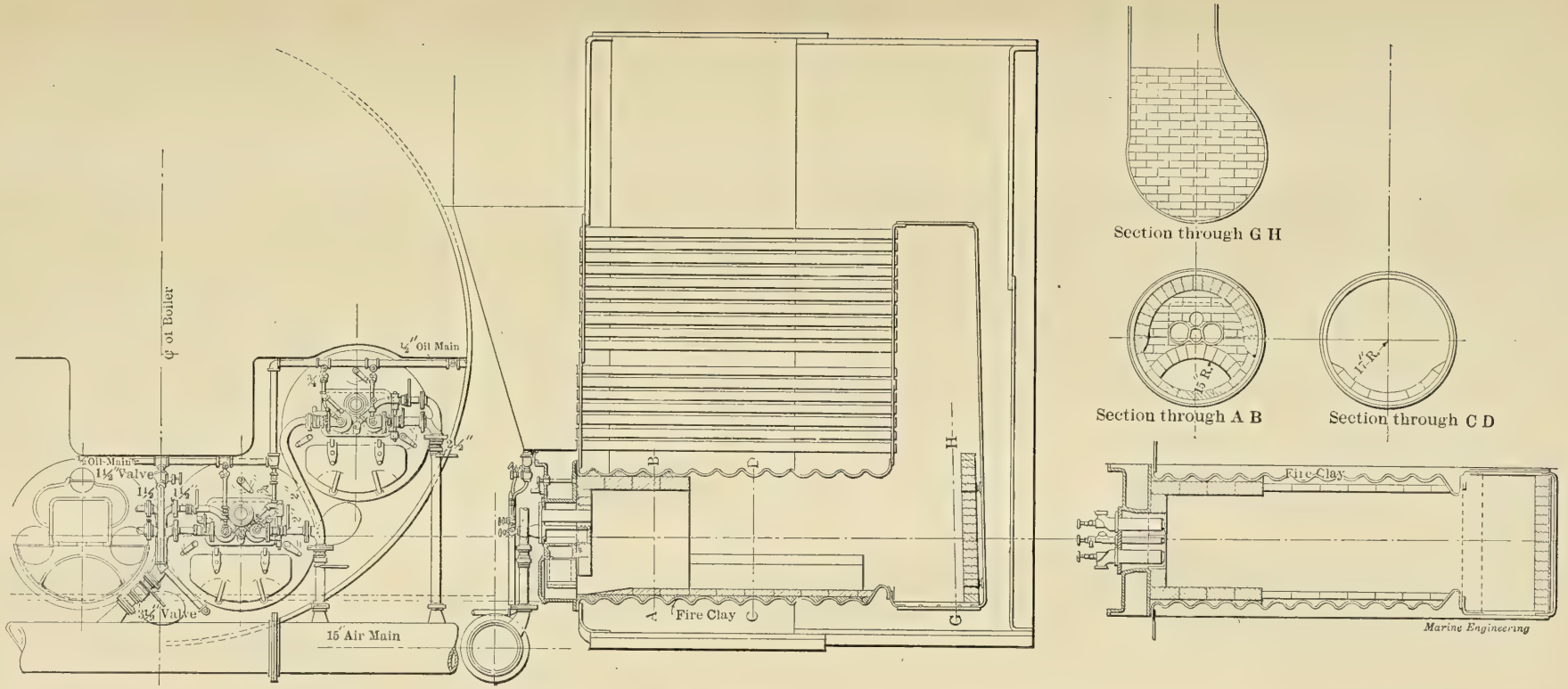
The *Nebraskan* was fitted for burning oil fuel by her builders, the New York Shipbuilding Company, but the equipment was not installed until after she had arrived at San Francisco, so she made the first trip out burning coal under the boilers. Since that day, until the ship sailed for New York, she has been engaged in the transpacific trade to Honolulu, and so successful and economical was the oil fuel apparatus that it was determined to send her round to the Atlantic as an experiment to demonstrate the adaptability of this fuel for a long run.

The company has collected a great amount of valuable data from which it was possible to calculate almost exactly the amount of oil to be required a day, and the speed in knots. In fact the ship arrived in New York on the day determined upon by previous calculations. This, of course, would be impossible with a coal burning vessel because of first the uncertainty of the time required for coaling at St. Lucia and Coronel, which requires anywhere between one and a half and five days; and, second, while with oil the exact steam pressure and revolutions may be maintained throughout the trip with very slight variation, in a coal burning steamer there is always more or less unavoidable fluctuation of steam pressure, especially at such times as cleaning the fires.

The ship arrived in port with as clean boiler rooms as when she left San Francisco. The oil burners are so efficient that complete combustion is obtained and there is absolutely no smoke, soot, or other deposit left on the furnaces or tubes or emitted from the funnel. In fact white paint is used in painting the upper boiler room.

DESCRIPTION OF MACHINERY.

The *Nebraskan* is fitted with two sets of three cylinder triple expansion engines 19, 31 and 54 inches diameter of cylinders, by 42 inches stroke. Steam is supplied at a pressure of 200 pounds by two single-end Scotch boilers. The boilers are placed with axes fore and aft with the rear ends through the engine room bulkhead. Four furnaces are fitted in each boiler, each furnace has separate combustion chamber and is equipped with two oil burners. Spiral retarders with



PATENT OIL BURNING SYSTEM AS INSTALLED ON THE STEAMSHIP NEBRASKAN WITH TWO LARGE AND ONE SMALL BURNER TO EACH FURNACE; OF LATE THE SMALL BURNER HAS BEEN REMOVED

eight turns per length are fitted in tubes. The feed water is driven by the pump through a surface heater where it is heated to over 212 degrees. This heater is composed of a nest of copper tubes around which flows the steam from the auxiliary exhaust, and is so connected that in port it may be used as an auxiliary condenser. The air and bilge pumps are direct connected by levers to the low-pressure crosshead. Each circulating pump is of the centrifugal type. A straight-tube Williamson evaporator, capable of evaporating 25 tons of fresh water in twenty-four hours, is fitted in the upper engine room. The electric lighting plant consists of two sets of direct-connected General Electric generators each of ten k. w. A steam steering gear is placed in the upper engine room and is of the Williamson type. Further particulars will be found in the data card on page 208.

OIL BURNING SYSTEM.

The oil burning equipment is of the Lässœ-Lovekin patent system, the principle features of which are, that oil under a pressure of about 15 pounds is atomized by compressed air at 1 1-2 pounds pressure and all the air to support combustion is heated before entering the furnaces. The apparatus is very simple and can be taken care of by an oiler. The air for combustion is heated by the Howden system.

The burner consists of a cast iron pipe about 4 inches diameter and 18 inches long. Into the rear end are lead the oil and air pipes, while into the front end is screwed a perforated plate forming the nozzle. Through the center of the burner is the oil supply pipe, and the rest of the space is filled with compressed air. A needle oil valve is placed at the inner face of the nozzle plate with stem extending back through oil pipe to the regulating hand wheel. In the center of the nozzle plate is

a 1-8 inch oil hole, and around it on a diameter of about 2 inches are drilled a series of larger holes with axes parallel, and inclined radially and tangentially to the axis of the burner. The air passing through these holes catches and atomizes the oil, and spreads the flame into a cone-shaped sheet giving a large surface for combustion. The blower draws its air through the heating tubes in the smoke box of the boiler, and delivers it to a large chamber run below the boiler room floor across the fronts of the boilers. Compression is so slight that the temperature is not increased but a few degrees above that of the regular entering air, viz., 250 degrees. There is a controlling valve for the air at the burner, and there is also a stop for the oil which comes down from above across the front of the boiler. Regulation of the oil is secured through the needle valve as above stated. To avoid the possibility of a burner clogging, it is the chief engineer's order to have one burner from each boiler cleaned on each watch. This clogging up, however, practically never occurs, as the oil is strained beforehand, and no deposit forms on the burner.

Oil is stowed in the peak tanks, the water ballast tanks forward of the boiler room and aft of the engine room, and in a deep tank placed forward of the boiler room. A cofferdam is fitted at the forward and aft ends of this deep tank. The supply of oil from the boilers is drawn from the deep tank, which acts as a settling chamber for removing the entrained water in the oil. This tank may be filled from any one of the water ballast compartments by means of a steam pump placed in the engine room and a manifold and pipes similar to water ballast system. The oil supply from the tank is taken by a steam pump and discharged into a vertical cylindrical heater under pressure of about 15 pounds. In this heater is a coil into which exhausts the auxiliaries of engine and boiler room sufficient to raise the temperature of the oil to about 180 degrees. At this temperature the oil becomes very much thinner, *i. e.,* of less viscosity, so that it may readily pass through the pipe and to the burners. The discharge from the heater is passed through a strainer box fitted with duplicate strainers. Should the oil in the deep tank become too chilled for readily passing to the pump, steam may be turned on into coils placed in the tank near the suction, but this has never as yet been necessary. A No. 4 Wilbraham blower is placed opposite each boiler and is driven by a single cylinder vertical steam engine. As above stated, the suction of the blower is through the air duct at the base of the air heater in the smoke box. The entire plant of oil pump, heater, blower, etc., is in duplicate, each capable of working the two boilers at one time.

It is estimated that the fuel oil auxiliaries indicate about 30 horse power, taking on an average of 60 pounds of steam per I. H. P.

MARINE ENGINEERING DATA CARD. **MAY, 1904.**

NAME—Nebraskan. NATIONALITY—American. TYPE—Ocean freighter.

LAUNCHED—1902. BUILDER—New York Shipbuilding Co. OWNERS—American-Hawaiian Steamship Co.

Length over all	371 ft. 6 ins.
" between perps	360 " 0 "
Beam, molded	46 " 0 "
Depth, "	27 " 2 "
Draft, mean load	24 " 0 "
Displacement, corresponding	8,650 tons
Oil bunker capacity	1 200 bbls.
Water tanks under engine room	150 tons
Number of steel decks	3
Engines: Number	2
Type	3-cylinder triple
Cylinder diameters	19, 31 and 54 ins.
Stroke	42 "
Condensers, cast-iron shell separate from framing surface (2)	5 230 sq. ft.
Boilers	2
Diameter	16 ft. 3 ins.
Length	11 " 6 ins.
Working pressure	200 lbs.
Furnaces, number each	4
Inside diameter	41 ins.
Tubes, number each boiler	390
Diameter outside	3 ins.
Length between sheets	8 ft. 3 "
Combustion chambers, separate for each furnace.	
Depth, top, 27 ins.; bottom	30 ins.
Grate surface, two boilers	156 sq. ft.
Heating " "	6 000 " "
Propellers: Material, cast steel hub bronze blades.	
Diameter	13 ft. 0 ins.
Pitch	17 " 0 "
Area developed	55 sq. ft.

TRIAL DATA. **MARINE ENGINEERING DATA CARD.** **MAY, 1904.**

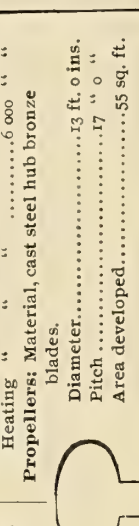
NAME—Nebraskan. NATIONALITY—American. TYPE—Ocean freighter.

LAUNCHED—1902. BUILDERS—New York S. B. Co. OWNERS—American-Hawaiian Steamship Co.

Averages for entire voyage between New York and San Diego, Cal.

FUEL	COAL.
	OIL.
Left	S. D., Feb. 3, 1904.
Arrived	N. Y., Mar. 26, 1904.
	days. hours. min.
Time of voyage	52 5 03
Steaming time	51 7 26
Detention in Strait of Magellan	21
Distance covered, nautical miles	12,726
Draft, mean, leaving	25 ft. 1-2 ins.
" " arriving	21 " 8 1-2 "
Displacement, mean for trip	8,417 tons
Steam pressure	180 lbs.
Throttle	Full open
R. P. M	73.83
I. H. P., main engines	1,986
I. H. P., total	2,196
Average speed, knots	10.35
Slip of propellers, per cent	16.56
Time out of dry dock from arrival in port	6 mos. 3 days
Admiralty coef	230.

Oil, Bakersfield residium	150° B at 60° F.
Barrels of oil for trip, total	8,826 bbl.
" " per hour	7.17 "
Lbs of oil per I. H. P. per hour	1.10 lbs
Miles per barrel of oil	1.44
Air pressure at fan	0.8 in.
" " blowers	1.5 lbs.
Temperature oil in heater	150° F.
" base of stack	495° F.
Kind of coal	Eureka and Coronel
Coal for trip, total	2,269 tons
" per hour, average	3,933 lbs.
Miles per ton of coal	5.85



OPERATION.

This system has been found to give great satisfaction in many ways. In the first place, the fire room force has been cut down. With coal, three firemen and two coal passers to a watch were carried; with oil, there are two, one termed "oil tender" and paid the same rate as the water tender, and the other a "wiper," rated as coal passer, to a watch. The water in main boilers is looked after by the engineer, as the rear ends of the boilers which project through the engine room bulkhead are fitted with gauge glasses, etc.

Regulation is attained to a very fine point. A peep-hole is fitted in each furnace door. When running full power the two burners on each furnace practically fill the entire furnace with incandescent flame. The bottom of the furnace is lined with brick, and the throat has a brick arch sprung around it to protect rivets, etc. A brick wall is built up at the back of each combustion chamber to a point a little above the top of furnace. This construction is shown in the drawing on page 207.

While there is great saving in weight of fuel, and in fire room force, there is also in the favor of this oil burner the fact that there are practically no repairs required on the boilers. The even, constant heat, and absence of cold draft, due to keeping furnace doors closed, have cut down repairs required on the boiler to practically nothing. As there is no deposit from the oil, the tubes and combustion chambers do not have to be cleaned and heating surfaces remain at highest efficiency.

By reason of past experiences and records, it is now possible to so regulate the burners that any steam pressure up to that allowed may be maintained for days at a time with but very slight variation. It is stated that on this trip of the *Nebraskan* the maximum difference was 2 pounds for the entire run.

LOADING.

In place of its taking several days to fill the coal bunkers, it requires but three hours to receive 1,200 barrels of oil. The oil from the supply on shore is pumped into the deep tank, then by means of the oil manifold box and piping, it flows by gravity into any one of the water ballast tanks. When the oil is being burned, each day the deep tank is filled from one of the other tanks to a certain level sufficient to last for twenty-four hours. Because of the great care observed in making these oil tanks watertight at the time the ship was built, no leakage, whatever, has occurred.

PERFORMANCE.

Bakersfield oil has an asphaltum base and the grade burned on the *Nebraskan* has been distilled once to drive off the lightest oils and contains about 17,000 B. T. U. per pound. In figuring the oil per I. H. P. the power is estimated by indicator cards and the average revolutions throughout the trip, and is not a fancy figure for temporary conditions.

Taking into consideration first, saving of labor; second, saving of weight of fuel carried; third, decreased repairs to boiler; fourth, facility and perfection of regulation; fifth, absence of soot, ashes; sixth, increased speed; seventh, less delay in time required in loading, we can surely estimate a great saving for the oil fuel. The chief objection to its use appears to be the fluctuation in the price of oil fuel on the Atlantic, and the somewhat uncertainty as to its supply. On the other hand must be mentioned, first, the increased cost of installing the oil equipment, and second, the necessary greater repairs to such equipment. It is stated by the company, however, that the last item is exceedingly small.

For the purpose of comparison there is given page 208 the engineer's report for the first passage of the *Nebraskan* from New York to San Diego, commencing August 7, 1902, on which coal was burned. In comparing this with the last passage of the ship with oil fuel special attention must be given to the difference in the average slip for each passage. Coming out, the ship's bottom was cleaned and the slip amounted to 11.9, while on the return passage the ship had been out of dry-dock for six months and the average slip was 16.56 per cent. Even with this increased slip against the oil burning passage there were 945 tons less of oil fuel burned than coal for the outward passage. On the other hand, the distance run on the outward voyage was 554 miles more than on the return run, because of necessary stops for coaling at St. Lucia and Coronel. We may easily calculate the time that would be saved on the return voyage if the slip had been the same as on the outward voyage, and this equals 36 hours and 41 minutes. Ships on this run make about two round trips to New York a year. On the Pacific they call at the California and Washington ports and also at Honolulu. On April 17 the *Nebraskan* sailed for San Diego with a supply of Texas oil. She was put in dry dock, cleaned and painted prior to leaving so that the run out will be made under conditions nearer like her first voyage with coal. Then a fairer comparison may be made of the two fuels.

Through the courtesy of the general manager, Captain W. D. Burnham, the superintending engineer, V. F. Lässoe, and his assistant, C. M. Magruder, the above facts were ascertained. John Mitchell is chief engineer of the *Nebraskan*.

The Dispersion of Fogs.—Not long since attention was called to the suggestion of Sir Oliver Lodge, that fogs might be dispersed by means of electric discharges into the atmosphere at high voltages. Tests which he had made were successful, though the area affected was quite limited, and it is doubtful whether his process could be carried out on a sufficiently large scale to make it of great value. This idea is brought to mind again by the work of two Germans, Richarz and Schenck, who have found a striking analogy between radioactivity and the behavior of ozone. Freshly prepared ozone has the power of causing condensation in a steam jet. Now, ozone is a gas which can be made easily in large quantities, and it might be possible to make use of its power to disperse fogs. The ozone could be set free at various points, and would rapidly disperse itself through the fog. Just what effect would be secured can not be said. It may be that the condensing effect is too slight to be of any practical value. However, further investigation of this property should be made, with a view to determining how long its power persists, and what quantity of ozone is required to keep a certain volume of air clear. The experiments could be conducted easily at some of the ozone water sterilizing plants which are now in operation.—*Electrical Review.*

GAS AND OIL ENGINES ON SHIPBOARD.*

BY JOHN E. THORNYCROFT.

It has been recognized for some time by engineers who have to do with large power installations for land purposes that the reciprocating steam engine has been developed to a stage that cannot easily be improved upon; and that if greater economies are required, they must look either to the steam turbine or the internal-combustion engine. Naval architects and marine engineers have been quick to take up the steam turbine; but although the internal-combustion engine has been developed to a high degree of efficiency on land, it has, up to the present time, only been used to a limited extent for marine purposes, and then only for driving launches and small craft.

The advantages which oil and gas engines offer are so great that it is difficult to understand why they have not been more largely used. They necessitate the employment of some complications which steam engines avoid; but the one great advantage of their requiring neither boilers nor condensers will, it is thought, be found to more than compensate for these complications. Before making a direct comparison it will be well to consider the different systems, and the way in which they work.

CLASSES OF ENGINES.

Internal-combustion engines may be divided into several classes, according to the fuel they employ:

I. In which the combustible employed will vaporize at atmospheric temperature.

II. In which the combustible requires vaporizing by heat or by spraying.

III. Gas engines, using gas from some form of producer using solid fuel.

Engines of the First Type.—The Daimler motor is representative of the first type, and practically all the engines working on the Otto cycle with this class of fuel are developments of Daimler's orginal engines, and are the simplest and lightest of the different types, as the fuel, in the form of petroleum spirit, is drawn into the cylinder with the amount of air necessary to burn it by the suction stroke of the engine. The apparatus for mixing the spirit with the air is of a very simple character, and the class of fuel permits of a high degree of compression being employed without danger of premature ignition; this high compression produces a high explosive pressure, and the cylinders of the engine are small in proportion to the power, and so the engine is light. Engines have been made by the German Daimler Company up to 300 brake horse power, by several American builders up to 150 brake horse power, and by Messrs. Vickers, Sons, & Maxim up to 300 brake horse power for British submarines.

Most of the leading motor-car builders, both on the Continent and at home, have built engines of considerable power of this type, which have been fitted to launches. In America there are a number of firms building small types of engines which do not follow the Otto cycle, but give an impulse at every revolution by using the under side of the piston and crank chamber for pumping the charge of explosive mixture into the cylinder. This type cannot be run at a high speed, and is not suitable for large powers.

Engines of the Second Type.—There is a much greater variety of engines coming under the second heading, as the difficult problem of vaporizing the fuel has been treated in a variety of ways by different builders.

The stationary oil engine has been made very perfect for work where there are no very rapid or great changes of load; but for marine purposes, where a considerable amount of variation takes place in manœuvering, the problem becomes much more difficult. Most of the engines work on the well-known Otto cycle, and the variations occur in the different methods of introducing the fuel and vaporizing it. In the case of the Priestman and Griffin—two of the earliest—the fuel is sprayed by air pressure into a vaporizer heated by the exhaust products, and then taken into the cylinder on the suction stroke. In the Vosper and Roots engines it is either pumped or measured into a vaporizer without being sprayed.

In the Hornsby engine the oil is pumped directly into an extension of the cylinder, which is maintained at a high temperature, and the air is introduced separately. This method has the advantage of great simplicity, as no igniting device is required, as the heat of this chamber is sufficient to ignite the charge on compression; but it is only possible to work with a very low compression, to avoid premature ignition, and therefore the type of engine is necessarily a heavy one.

The Diesel engine, which has, as yet, been only used in one or two cases for marine purposes, is a most interesting type. It works on the four-stroke cycle, but sprays the oil into the cylinder by means of compressed air at the end of the compression stroke, the compression being so high (viz., about 500 lb.) that when the oil is sprayed it at once ignites owing to the heat of the compression, which is about 1000 deg. Fahr. There is no actual explosion, as the fuel is introduced into an excess of air, and burns as it is injected. A gradual and complete combustion of the fuel takes place, resulting in a very high economy. The power can be regulated to a great nicety, as the fuel is always burned at the same temperature, but in varying quantities. The engine is, however, necessarily a heavy one, to withstand the very high pressure, and the lightest type so far gives only about 10 horse power per ton.

The Strickland engine is designed on the same principle, of injecting the fuel at the end of the compression stroke, but does not compress to more than 200 lb., and therefore has to use an igniting device. It is also arranged to work as a two-cycle engine, giving an impulse at every revolution, as some of the Diesel engines have done. It is fitted with a prolongation of the piston to form a pump to supply the air for the scavenging stroke, and the necessary air for combustion.

It would seem that an engine of this type, not working at too high a compression, so that it does not require to be so very strongly built, and giving two impulses for one of engines working on the Otto cycle, should have very great advantages, as a high mean pressure can be obtained without danger of premature ignition, and no vaporizers are required for the fuel, the vaporizers being always the part of the engine

* Paper read before the Institution of Naval Architects, London, March 24, 1904.

most difficult to design, and requiring the largest amount of attention.

Engines of the second type will always be more difficult to handle, in consequence of the vaporizing difficulties, than the first and third; but it is probable that because of the portability, safety, and comparative cheapness of the fuel, they will be used very extensively.

Engines of the Third Type.—The gas engine has hardly yet been tried for marine purposes; but, owing to the recent great improvements in gas producers, it is thought that they will soon be used extensively.

An engine designed for working with gas from solid fuel consists essentially of the same parts as engines of the first and second classes without the apparatus for vaporizing the oil or spirit, the gas producer taking the place of the vaporizer, but being necessarily much more cumbersome. But the gaseous fuel which is produced is essentially different to that produced by the vaporizer or carburettor of engines of the first two classes, as it is a stable gas, and can be stored if desired, and the vapor cannot; so that when manœuvering is taking place, and the engine is being stopped and started, the producer is not entirely put out of action, as is the vaporizer, but to some extent can act as a flywheel and reserve of power, like a steam boiler.

The recent improvements, which have enabled the producer to be worked without the reservoir for the gas, the engine sucking the supply directly from the producer, makes the apparatus much less bulky, and therefore better adapted for marine purposes.

The first type of engine is necessarily the lightest, as there is no vaporizer or producer, the fuel being vaporized by the simple expedient of sucking the right amount of fuel in with the air to the cylinder. Engines of this class are being made to weigh not more than 10 lb. or 12 lb. per brake horse power. Comparing this figure with that of the modern torpedo boats or destroyers, which is 50 lb. per indicated horse power, it is evident that the naval architect has great possibilities with this type of engine. There is every prospect that engines of the second class will be built, including the vaporizer, for not more than 25 lb. per brake horse power, for moderate sizes. The engine of the third class should not be heavier; but, of course, there must be added the weight of the producer.

Starting and Reversing.—The smaller types of engines for launches are very easily handled, it being possible to start them up by a few turns of the engine; but when the size gets too great to be man-handled, other means of starting have to be devised. In the large engines used in submarines, the engine is used in conjunction with electro-motors and dynamos, so that the motor can be used for starting up the engine.

In the case of the first and third classes, the starting is not very difficult, as the engine can be turned slowly with a suitable turning gear, and then, the cylinder being full of an explosive charge, they can be fired electrically at the right time, and the impulse is sufficient to carry the engine round for several revolutions, and set it in operation.

In the case of the second class this is not practicable, and it is necessary to have a reservoir of compressed air or gas of sufficient volume to give the engine several turns working as a pressure engine; this, of course, necessitates additional valves for the purpose. In smaller motors it is possible to reverse either by a reversing screw, or in some instances it is accomplished by stopping the engine, and by having suitable cams for operating the valves and starting the engine in the reverse direction by hand; but this has not been found very satisfactory, and the best practice seems to be to fit the engine with a suitable reversing gear and clutches for throwing it in and out of gear. It is at present unknown to what sizes these reversing gears can be successfully built, but recent improvements in clutches made by Professor Hele-Shaw go to show that there should be no great mechanical difficulties in producing them up to several thousand horse power.

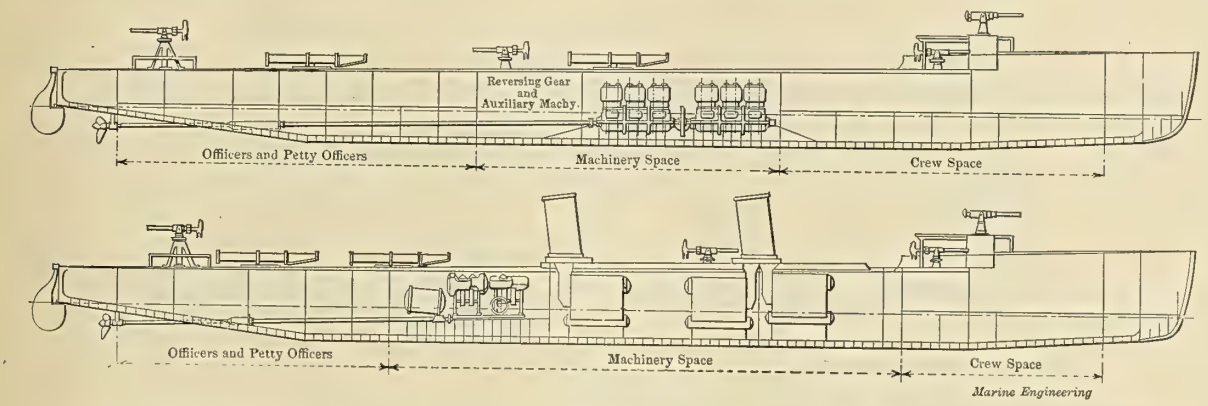


DIAGRAM SHOWING COMPARISON OF SPACE DEVOTED TO MACHINERY IN A GAS ENGINE- AND STEAM-PROPELLED TORPEDO BOAT.

The Bertheu engine has been specially designed with a view to making it very easily handled. Reservoirs are provided into which the engine compresses or delivers the burned products of combustion at a high pressure; compressed gases in this reservoir being used when required for starting up the engine, or giving it a few impulses in a reverse direction when it is required to go astern. The engine is provided with a double set of cams, either of which can be thrown into operation, and at the same time the engine is converted from a four-cycle to a two-cycle, to better enable it to maintain its speed when it is being driven by the compressed gases as a pressure engine. The author's firm are building engines of this type of considerable powers, and he thinks

that probably, although the engine is complicated by these appliances, it will be found better in the larger sizes than any reversing gearing.

A comparison of the weights and space occupied by comparatively low-powered engines of the first class, fitted to launches in the place of steam engines and boilers of the same power, shows very greatly in their favor, but when petrol is used as fuel, it will be found more expensive than coal to do the same work. On the other hand, as the engines are practically automatic in action, and can be started at once (requiring no preparation like a steam boiler), an engine-driver can usually be dispensed with; and, as the steersman can do all the work of controlling the vessel, it will frequently be found cheaper to run with this class of engine than with steam.

While there is very little danger from fire with properly-constructed engines, fitted with electrical ignition, and using spirit or oil of a low-flash point in open boats, the risk must not be disregarded where they are fitted in a closed engine room below decks.

Captain du Boulay has devised an arrangement by which only a small quantity of fuel is kept in the engine room, in a small tank, any leakage draining directly overboard. The main supply is stored in a tank in a specially bulkheaded compartment, which also drains overboard; and in some cases the sea is allowed to flow into it and around the tank, thereby avoiding any possibility of the leakage of oil into the bilge of the vessel.

With engines of the second class, using oils having a flash point of above 75 deg. Fahr., there is practically no danger from fire; and when the engine will work with less than 1 lb. of oil per horse power hour, the cost of working will, as a rule, be found less than that with the equivalent steam machinery; but, as yet, there has always been the disadvantage of an objectionable exhaust.

The Diesel engine costs only one-tenth of a penny per hour, as it works with unrefined oils, which can be bought for *2d.* per gallon, and uses less than half a pound of oil per horse power hour. Only the most economical steam engines, supplied with coal at not more than 10*s.* per ton, can equal this performance.

It is well known that gas engines of even small powers, supplied with producer gas, give considerably more power per pound of fuel than could be obtained with a steam engine and boiler, and when large plants are used, a given quantity of fuel will produce about four times the power obtainable with ordinary steam engines.

Gas producers must be divided into two classes—those which work with non-bituminous coal, and those which work with bituminous. The former class working as a suction producer is very simple, and weighs, as made for land purposes, considerably less than the ordinary type of steam boiler to do the same work but, owing to its being restricted to one class of fuel, its use must be very limited for marine purposes.

The producer invented by Dr. Mond for using bituminous fuel has not yet been worked out suitably for marine purposes, and as used on land is heavier than boilers of the same power, but it seems probable that, owing to the much greater economy obtained and the rapid development which is going on, it will soon be possible to employ producers of this type.

The illustrations on page 211 show the relative space occupied by the machinery of a torpedo boat destroyer fitted wth the usual machinery, and an engine of the second class working on the Otto cycle at the same piston speed as the steam engine.

Other drawings and views were given of the Bertheau oil engine, which has already been described in *Marine Engineering* in December, 1903.

DISCUSSION.*

In the discussion which followed, Captain du Boulay said that he had been experimenting with petrol and paraffin engines since the year 1886, his principal effort being to get over the danger of fire from petrol. He had fitted several boats in which the main quantity of petrol was carried on deck, the arrangement being such that any leakage was passed into the sea. The vaporizer, or carburettor, was a source of danger if it failed to work, as there would be overflow and leakage of oil. He had recently managed to get the whole of the petrol stored on deck, so that there would not be any at all in the engine room, the mixture being drawn down for use by a suction pipe. As air was drawn in—there being a partial vacuum—if there were any defect in this pipe, the vapor would not escape. The arrangement, however, needed very careful fitting to get a regular and proper supply of vapor.

Mr. Linton Hope referred to some boats designed by him, and fitted with Blake motors, one of which—a seagoing yacht—had been running for some time, and had given great satisfaction to the owner, who said he had no trouble with this class of engine. It ran at 400 revolutions, occupying a space of 3 feet by 6 feet. The vessel made a speed of 7 knots with 35 brake horse power. The weight was 10 lbs. to 12 lbs. per horse power. Another oil motor which he had used, and which gave 172 brake horse power, weighed under 10 lb. per horse power.

Mr. A. E. Seaton failed to see that Mr. Thornycroft had made good his title to "Some Advantages of Gas and Oil-Engines for Marine Purposes," for, as far as he could see, there were not any advantages for ordinary marine propulsion. He did not think that the internal combustion engine would drive steam out of the field; there would be many difficulties. What he would ask would be as to the rate of insurance; and, How would a captain like to have on board an engine that would not reverse and was not sure to go ahead or astern when called upon to do so? Latterly he had tried to get some makers of oil engines to tender for one of 500 horse power, but he had failed to do so; they could only offer two motors of 250 horse power each. He would like to know how long the pistons would run before they melted. The first rotary oil engine was used in the year 1818, but that was worked with turpentine.

Mr. S. W. Barnaby said he thought Mr. Seaton was in too great a hurry in criticising the application of the oil engine to big ships. In regard to seawork, however, he would say that his firm had recently had in their hands a small boat which had come across the Atlantic, and which was fitted with an oil motor. Sir William

* This discussion is taken from *Engineering*, London, April 1, 1904.

White, in his presidential address before the Institution of Civil Engineers, had forecast the use of the oil engine and the gas engine with the producer. He thought Mr. Seaton might find this come into operation sooner than he anticipated.

Mr. Evans said that the cost of fuel would be a bar to the application of the oil engine to big vessels.

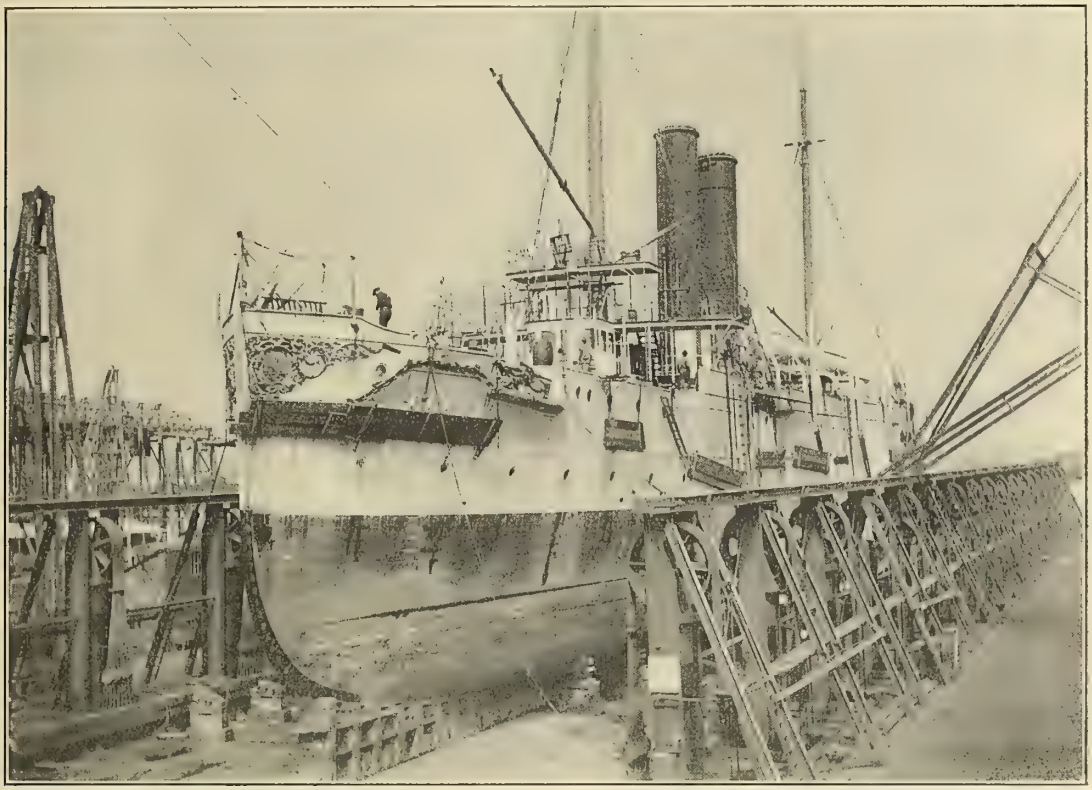
Mr. J. E. Thornycroft also spoke of the difficulties of obtaining the necessary fuel for oil engines. At present, the demand for hydro-carbon oils for illuminating purposes was very large, and if big ships were to take to using it, there would not be enough in the world to go round; so far as large powers were concerned, solid fuel would be the solution. Mr. Seaton had spoken of the difficulty of keeping a gas engine at work, but he would state that there had been engines of this type running for six months without stopping. (Mr. Seaton here interposed, asking for instances, which Mr. Thornycroft gave.) Continuing, the speaker said that the great question before marine engineers, in the application of internal combustion engines for heavy work, was, What form of producer could be used on board ship? We wished there had been some discussion on this subject. The gas engine, with producer, had been worked with tug boats on the Continent.

Water-Tube Boilers for Warships.—The Government has decided to install eight Babcock & Wilcox boilers to replace the Scotch boilers in the *Indiana* and four Babcock & Wilcox boilers on the monitor *Monterey*. The battleships *Vermont, Kansas* and *Minnesota* are also to be fitted with boilers of this make.

Trial Trip of the U. S. Protected Cruiser Tacoma.

The trial trip of the U. S. protected cruiser *Tacoma*, which took place in Santa Barbara channel, Cal., on November 30, 1903, was of special interest because this ship was the first of her class to make her contract speed of 16 1-2 knots. The trial speed for four hours was at the rate of 16.62 knots. The ship was built by the Union Iron Works, San Francisco, Cal., and is one of four built from the same plans. The designed horse power was but 4,500, but on trial the average developed was 5,233.5 I. H. P., while the speed was only a fraction in excess of the requirement.

The *Tacoma* is a shallow draft protected sheathed cruiser 292 feet length on the water line, 44 feet beam, 15 feet 9 inches draft and 3,200 tons displacement. Other particulars will be found in the data card on next page. She carries ten 5-inch quick firing guns, 50 calibres long; eight 6-pounder rapid firing guns; two 1-pounders; four machine guns and one field gun. A protective deck, varying from 1 to 2 inches thick on the slopes to 1-2 inch on the flat, is worked in. She is sheathed with hard wood over which is annealed copper sheathing which, with the shallow draft eminently fits her for service in tropical waters far away from dry docks.



UNITED STATES PROTECTED CRUISER TACOMA IN DRY DOCK AT SAN FRANCISCO.

MACHINERY.

The ship is propelled by two sets of four-cylinder, triple expansion engines placed abreast of each other with water-tight bulkhead between. The cylinders are 18, 29, 35.5 and 35.5 inches, and the common stroke is 30 inches. The H. P. is fitted with one piston valve, the I. P. with two piston valves and each L. P. has a

double ported slide valve; the arrangement of cylinders from forward aft is: forward L. P., H. P., I. P.; aft L. P. The crank shaft is made in two sections, of forged steel; when bolted together the cranks are at 90 degrees, the sequence being H. P.; I. P. forward L. P. aft L. P. The bedplates are of cast steel ∩ section, in three parts and bolted together. The engine framing, columns, connecting rods, piston rods, and eccentric rods are made of oil tempered nickel steel, tested for a minimum tensile strength of 90,000 pounds per square inch an elastic limit of 65,000 pounds of 15 per cent. reduction area; the elongation was 25 per cent. Stephenson valve gear and a steam floating lever reversing gear is used.

The circulating pump in each engine room is of the centrifugal type and is driven by a two-cylinder 6 by 6 by 6-inch engine. Each air pump is direct connected to the forward low pressure crosshead by levers and is 22 inches diameter by 10 inches stroke which discharges either into the lower filter tank or into a hot well tank some 12 feet above. An independent cylindrical steel plate condenser is placed in each engin room. All pumps are of the Davidson pattern. The water flows from the upper tanks by gravity through the feed water heater to the independent main feed pumps in the fire rooms with bypass around heater. The main feed pumps are 10 by 7 by 12-inch vertical double acting and are fitted with air chambers on suction and discharge ends to eliminate hammering.

MARINE ENGINEERING DATA CARD. **MAY, 1094.**

NAME—Tacoma. NATIONALITY—United States. TYPE—Protected cruiser.
LAUNCHED—1903. BUILDER—Union Iron Works. OWNER—United States Navy.

Length, load water line	292 ft. 0 ins.
Beam, extreme	44 " 0 "
Draft, normal	15 " 9 "
Displacement	3,200 tons
Immersed midship section	620 sq. ft.
Coal supply, normal	467 tons
Battery, main	ten 5-in R. F. G.
" secondary, eight 6-pdr. R. F.; two 1-pdr. R. F.; four colt; one 3-in. field.	
Complement	21 officers, 281 men
Engines:	two 4-cylinder triple
Cylinder diameters	18, 29, 35.5, 35.5 ins.
Stroke	30 "
Valves	11-in. piston; 1 on H. P., 2 on I. P.
I. H. P., designed	4,500
R. M. P., "	175
Cooling surface, 2 condensers,	6,004 sq. ft.
Shaft diam., line and propel., (hole 5 3-8 ins.)	9 ins.
Crank (hole 5 ins.)	9 1-4 "
Thrust (hole 5 3-8 ins) 14 ins. and 9 1-4 "	
Connecting rod, distance bet. centers	67
Propellers: Built-up manganese bronze, 3 blades	
Diameter	10 ft. 0 ins.
Pitch (adjust. 10 1-2 ft. to 12 1-2 ft.), 11 " 6	
Area, developed	25.77 sq. ft.
" ratio developed to disc	33.8 per cent
Boilers: Type	6 Babcock and Wilcox
Steam pressure	275 lbs.
Tubes, each, 406 2-in.; 17 4-in.; length, 8 ft. 11 ins.	
H. S., total	13,200 sq. ft.
G. S.	300 " "
H. S. ÷ G. S.	44.
Weight, dry, total	71,860 lbs.
Speed trial	16.62 knots
I. H. P. trial	5234.
H. S. ÷ I. H. P.	2.52
I. H. P. ÷ G. S.	17.45

The auxiliaries include a very complete equipment of pumps, evaporators, distillers, auxiliary condenser, four direct connected dynamos, steam steering gear, and refrigerating system. Electric motors are used for operating the ventilation fans, bulkhead doors, and two gypsey heads.

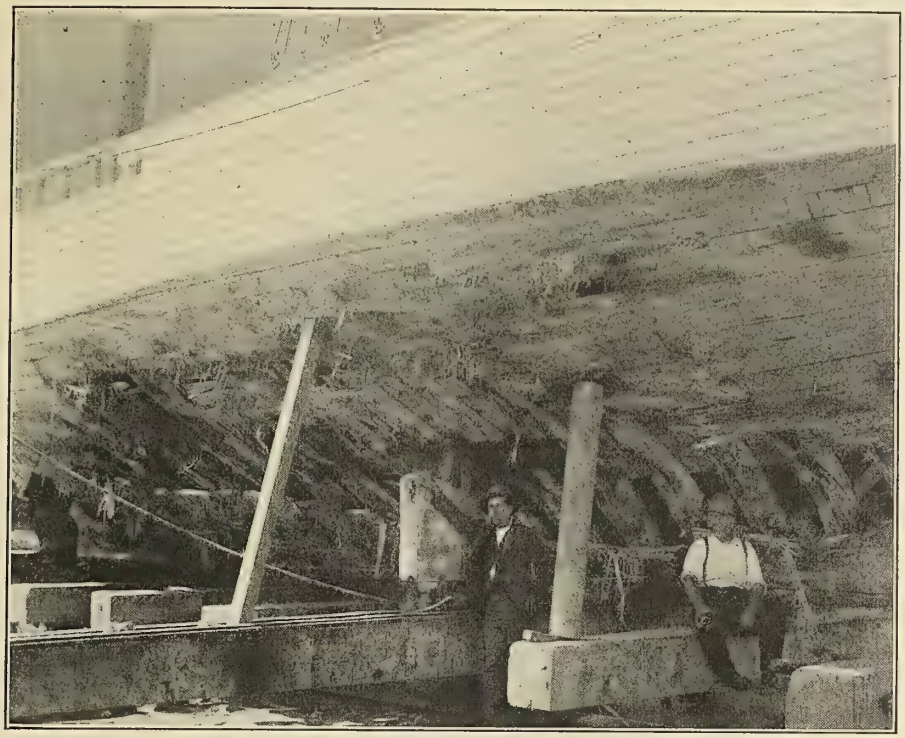
The propellers are three-bladed and of the built-up type of the dimensions given in the table. All castings are of manganese bronze and all surfaces are tinned. The tensile strength of the bronze is 55,000 pounds, elastic limit 20,000 pounds and elongation 20 per cent. Fairwaters are placed at the stern tubes on both sides of the struts and at the propellers.

There are two fire rooms, the forward one containing four water tube boilers and the aft one two boilers. All boilers are of the Babcock and Wilcox marine water tube type. Steam is carried at 275 pounds pressure. The closed fire room system of forced draft is used, two blowers being placed in the forward fire room and one in the after fire room and each is driven by a single valve compound engine. Each boiler has 406 2-inch tubes of No. 8 B. W. G. and seventeen No. 6 B. W. G. 4-inch tubes of 8 feet 11 inches length. The heating surface of each boiler is 2,200 square feet and the grate surface 50 square feet, and the total weight of the six boilers, dry, is 71,860 pounds. In each fire room is installed a patent ash ejector, also a two-cylinder ash hoist engine capable of raising a 300-pound bucket of ashes in five seconds. The boilers are tested at 400 pounds hydraulic pressure and 325 pounds steam pressure.

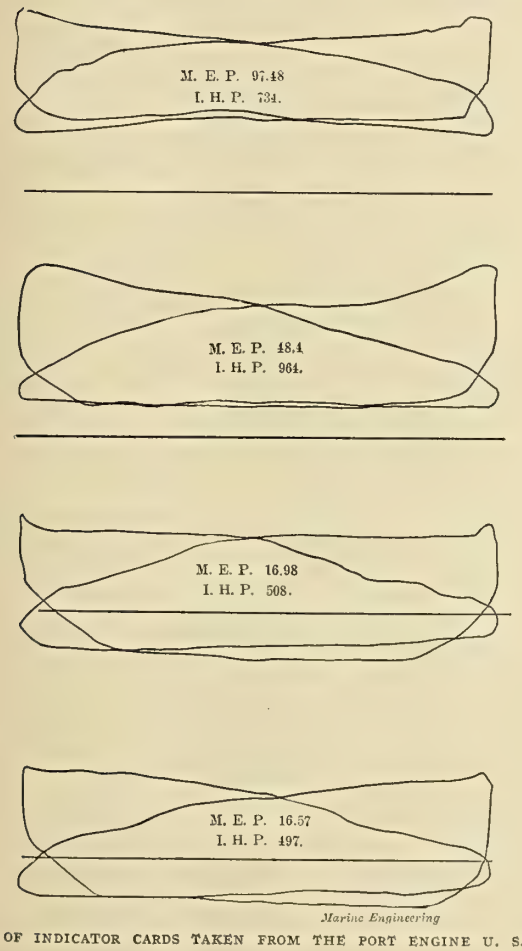
TRIAL.

On November 30 the ship crossed the starting line of the trial course, which was 33 nautical miles long, ran at full speed the length of the course, making the turn and return trip at full speed with engine running cool and boilers steaming well. An appliance which was found of great service in indicating the time for coaling each furnace consisted of a dial placed in each boiler room. On these dials were indicated by numbers the different furnaces and at the time for firing a furnace an electric light would be turned on at the dial behind the number of that furnace. The frequency of coaling was regulated by the engineer in the engine room. Following are the data for the run and for one set of cards from the port engine.

	AVERAGE FOR RUN.	FOR CARD ON PAGE 215.
Steam pressure, boiler	275 lbs.	278 lbs.
engine	245 "	250 "
Vacuum	27¼ in.	27 in.
Cut-off on all links	.7	.7
Throttle	Wide open.	
Revolutions, main engines	198.5	201.6
circul. pump	220 to 330	
blowers	640 to 810	
Strokes, main feed	18 to 36	
bilge	39	
water service	30.	
Temperature, engine-room	89 deg.	
fire-room	100 "	
injection	72 "	70.
discharge	108 "	112
feed	107 "	102
uptakes	550 "	
I. H. P. main engines	5233.5	2703
M. E. P. refd to L. P. start	25.6 lbs.	
end	40.5 "	
Speed	16.62 knots	



DAMAGE DONE BY CORAL REEF TO SCHOONER YACHT SYLPH.



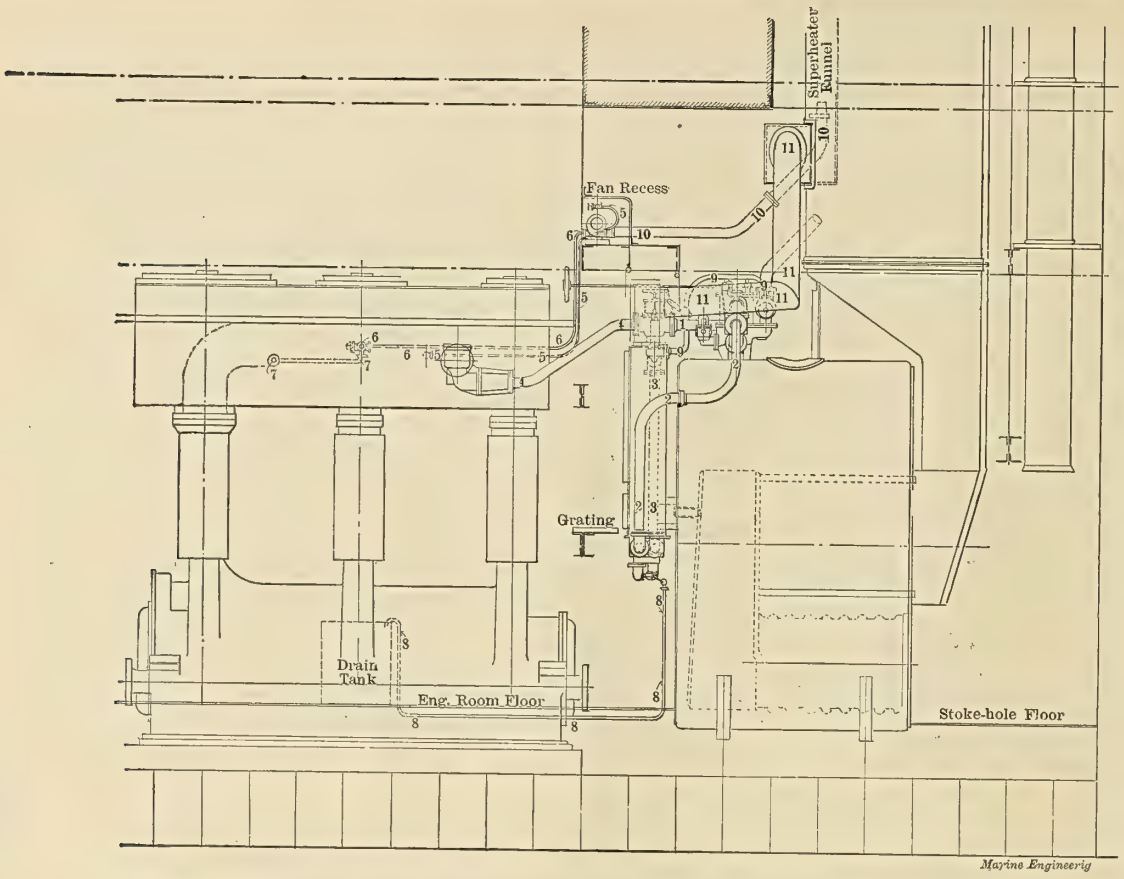
SET OF INDICATOR CARDS TAKEN FROM THE PORT ENGINE U. S. S. TACOMA.

Effect of Stranding on Coral Reef.

The accompanying photograph plainly shows the grinding effect that a coral reef has on the bottom of a wooden boat. As may be seen, the planking and frames are ground into fibre. The subject is the schooner yacht *Sylph,* as she was hauled out on a marine railway at Key West after stranding on a coral reef on February 18, near the entrance of the southeast channel to Key West.

The *Sylph* was sold as she lay on the reef, but was not hauled off until two weeks later, and then empty barrels were placed under her decks and her ballast taken out. The yacht, which was built at Port Jefferson, Long Island, in 1889, is of 68.32 gross tons, 72 feet 6 inches in length, 22 feet 5 inches beam and 8 feet 9 inches deep. She was owned by Mr. J. Birkly, of Minneapolis.

The "Technical World."—A new magazine, issued by the American School of Correspondence at Armour Institute of Technology, Chicago, Ill., appeared in March, and it is appropriately named the *Technical World.* In the editorial announcement it is stated that the purpose of the magazine is to render every assistance to students and to men interested in technical matters in general. It is promised that each issue will contain articles from eminent men, and that the advances in the branches of engineering, architecture, and textile manufacturing will be carefully reviewed on its pages. The first number is, indeed, very creditable, and, if it may be taken as an exponent of the future editions, the editorial success of the magazine is assured. The leading article is on radium, profusely illustrated, and written by Robert A. Millikan, of the University of Chicago.



ELEVATION OF ENGINE AND BOILER ROOM, SHOWING STEAM PIPING AND ARRANGEMENT OF SUPERHEATER.

The Central Superheater.

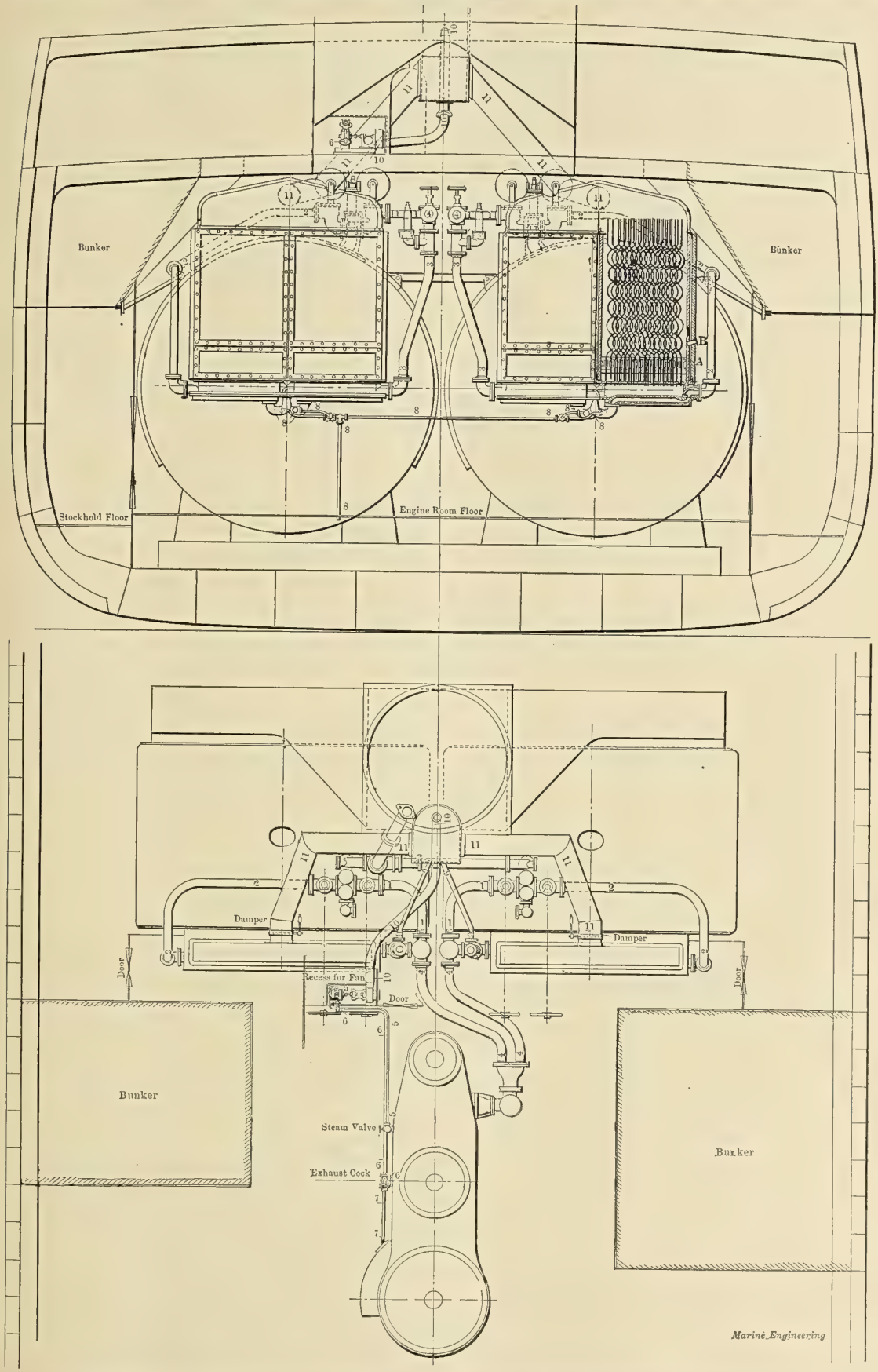
Nearly three years ago there was described in this paper the machinery of the famous Inch Line steamers *Inchmarlo* and *Inchdune,* which gave such remarkable results for economy on trial and in service. It will be recalled that steam superheaters of waved tubes were placed in the uptakes of the boilers, and above these were fitted the air heaters for the induced air system for supplying the furnaces.

Concerning the performance of the *Inchmarlo,* the builders and owners have given out a statement of a 380-day voyage recently completed nearly around the world, during which the coal supply was obtained just as the ship was able to get it at the various ports of call. The average consumption, with a carrying capacity of 5700 tons and an average speed of 9 knots, was 15 1-4 tons per day of 24 hours. It is also stated that the average horse power was in the neighborhood of 1,400 I. H. P. This works out to practically one pound of coal per I. H. P. per hour, a feat in coal consumption which in marine practice has hitherto never been touched. The figures are based on the owner's statement of the coal actually paid for during the voyage.

The ship was engined by the Central Marine Engineer Works of West Hartlepool, England, which company has recently installed the machinery on three new steamers, the *Queensborough,* the *Atlantic* and the *Britanic.* The first of these three has been in service several months, and a saving of about 10 per cent. in fuel is being effected. This is attained by increasing the temperature of the steam to nearly 500 degrees Fahrenheit, the boiler pressure being 160 pounds per square inch, corresponding to a temperature of 370 degrees Fahrenheit. In the *Inchmarlo* the steam pressure carried was 267 pounds and superheated to 57 1-2 degrees Fahrenheit, but it was later found that by reducing the pressure and increasing the superheat greater economy was effected. It is the builders' experience that with boiler steam at about 160 pounds pressure, every 10 degrees rise in temperature of the steam results in an economy of 1 per cent. This, while a rough-and-ready rule, is considered by the builders to be a perfectly correct one through their experience on several ships fitted with their superheaters.

The form of heater now being installed on the *Atlantic* and *Britanic* is herewith illustrated on pages 216 and 217, where are given the sides and end elevation of the boilers as well as plan.

The boilers and engine are placed in the same compartment, as shown in the longitudinal elevation, and the superheater is placed at the back of the boilers and connects with the top of combustion chambers through openings A, A. The casing containing the coils is heavily insulated with asbestos, and at the upper end has a funnel, 11, leading into the separate funnel placed inside the main stack. Steam may be taken direct from the boilers through pipes, 1, 1, but ordinarily it is led through pipes, 2, 2, to the headers at the base of superheater. The superheaters are drained by pipes, 8, 8, into a drain tank placed in the engine room. The steam passes up through the outboard nests of bent vertical pipes to the top headers, thence across to the inboard



ELEVATION AT BACK OF BOILERS LOOKING FORWARD, AND PLANS SHOWING ARRANGEMENT OF SUPERHEATER.

nests and down again. From the second bottom header it is carried through pipes 3, 3, to the main steam pipes, 4, 4. A small steam motor, which is really a triple expansion balanced turbine, and called the Central Rotor, is placed in a recess above the port boiler for driving a fan to induce a draft through the superheater. This fan was not installed on the *Queensborough,* where natural draft was relied upon, which was not altogether satisfactory during all conditions of wind and weather. This rotor is the only point of difference between the installations on the *Queensborough* and the later two ships. By means of this fan and the dampers in the funnels, 11, 11, the draft through the superheater may be controlled perfectly. A peep-hole is placed on the side of the superheater at B, and the front of the casings may be readily removed to inspect the tubes.

The steam for the turbine or rotor is taken from the intermediate pressure valve chest through valve and pipe 5, and the exhaust is returned to either the low-pressure receiver through 6, or to the condenser, through 7. Waste steam pipes, 9, are fitted for carrying off steam from the safety valves placed on the superheaters.

DESIGN OF A 6-HORSE-POWER, TWO-CYCLE MOTOR.

BY H. B. MAXWELL.

The two-cycle motor has until recently been in nearly entire possession of the field for boat propulsion, and now this field is being encroached on by the four-cycle automobile engine, the claims being made that the latter is more reliable in running and more economical of fuel for a given horse power. That this is a fact when the average two-cycle motor is considered cannot be disputed, but some of the brightest engineers connected with the gas motor industry have for some time past been giving their attention to the two-cycle motor, and by proper attention to details, have produced a machine that is claimed to be the equal of the four-cycle motor in regard to reliability and fuel economy.

The simplicity of the two-cycle motor is a great advantage, both from the point of cost of construction and maintenance; there is also far less to look after if the motor goes wrong. Any well constructed engine, either a two or four-cycle, will run satisfactorily if the following points be obtained: good compression, a proper mixture of gas or gasoline vapor and air, and a good hot spark properly located. With the two-cycle motor aside from proper lubrication these three points are all that need attention if the motor goes wrong; in a four-cycle motor there are in addition the valves, valve springs, cams, gears, etc., that may all be responsible for trouble, and cause the motor to balk or to loose power. We will now note a few points in two-cycle motor construction that have proved serious obstacles to many builders of this type.

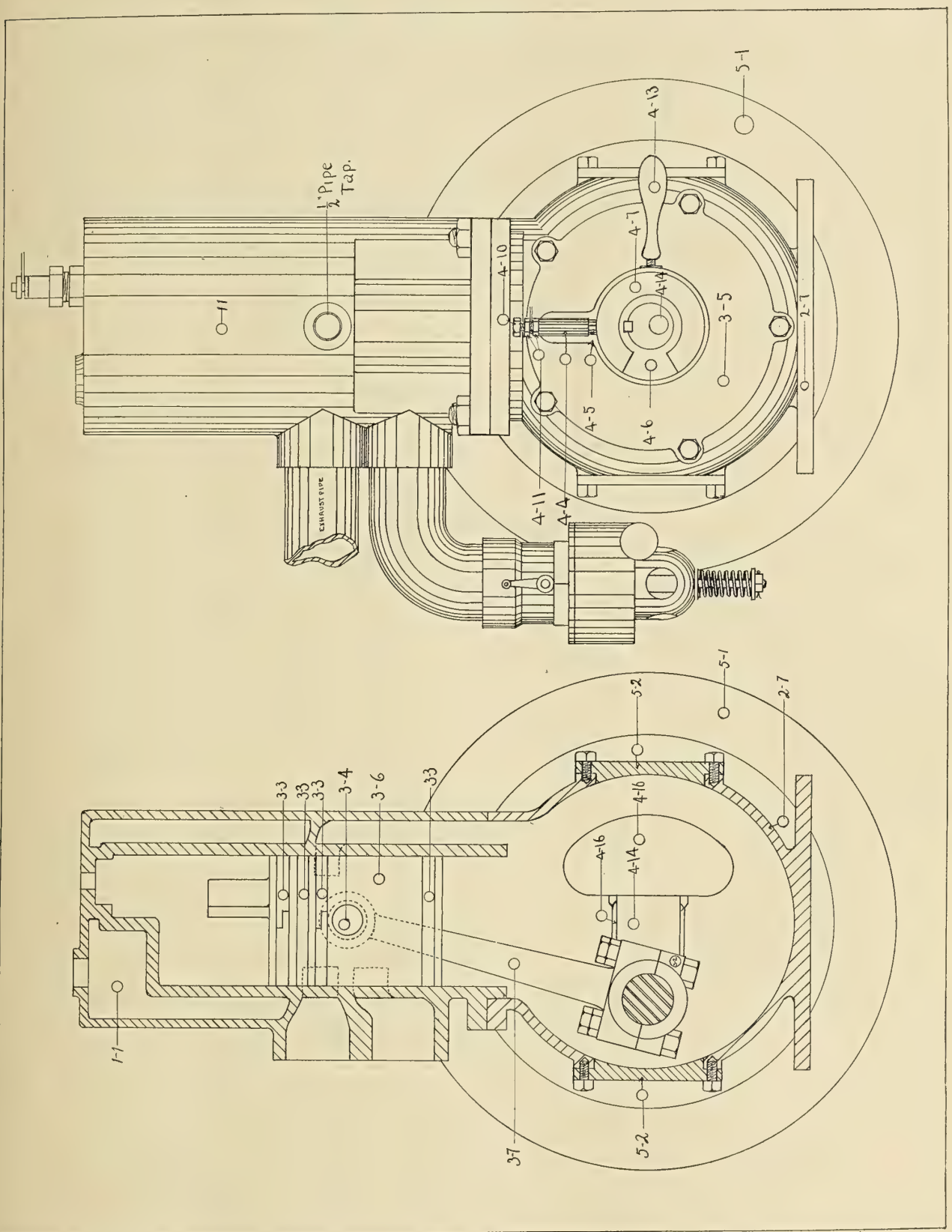
First and foremost, builders of two-cycle type have seldom or never attained the compression pressure common in the four-cycle type, and thereby the power of the two-cycle is but little if any greater than the power of a four-cycle motor of equal cylinder dimensions. Then again, the ports seem to have been designed without any regard to cylinder diameter and piston speed. In several makes the ports were so small that 350 revolutions per minute for medium size, and 500 to 600 for small size motors was about the limit of rotative speed when running light, and when under load, this speed frequently fell off ten to thirty per cent. In such cases had the ports been properly proportioned, the rotative speed could have been easily doubled and the torque would have held up in nearly constant proportion to the increase in speed.

Another serious defect results in placing the ports in the cylinder walls, and in not giving the proper lead to the exhaust port so as to reduce the pressure and allow the products of combustion to escape before the by-pass port from the crank case is opened. The deflector plate on top of the piston is another stumbling block, many being little if any higher than the width of the inlet port. This allows the incoming charge to pass over the deflector and a large portion of it to escape through the exhaust port—hence the waste of fuel usual to this type of motor. The deflector plate should be cast integral with the piston, and be at least twice as high as the width of the inlet port; in order to do this and have high compression the head will have to be recessed to allow the deflector plate to clear when the piston is at the top of the cylinder. By making the stroke a little longer than the bore and having a deflector plate of proper length, a two-cycle motor may be slowed down and run at a much slower speed than usual by means of the throttle, thus making it a very flexible source of power and approaching the steam engine in this respect.

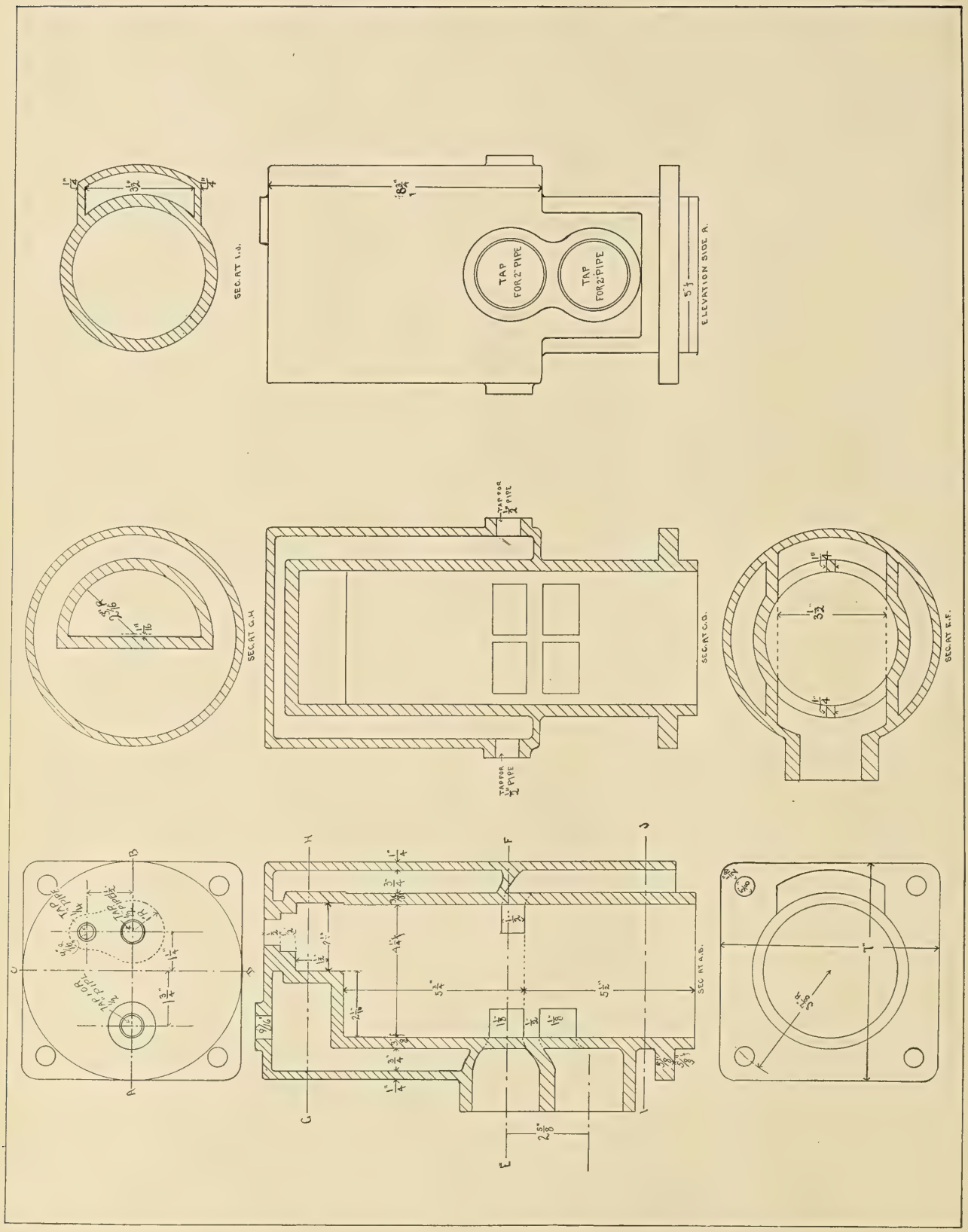
If the mixture and igniter are working right, there need be no fear of base explosions. The jump spark system of ignition is now used successfully on two-cycle motors and in some respects is preferable to the make and break igniter, the main one being in avoiding moving parts inside of the cylinder. It must be remembered that the spark plug must extend into the combustion chamber and not be in a pocket or side chamber, else when running throttled there will not be sufficient compression to force the explosive mixture back far enough to reach the igniter points, and misfires will result; the unexploded charge will explode in the muffler and give an exceedingly loud report similar to a cannon when fired. This will in all probability give a crank case explosion also and stop the engine unless it has a very heavy fly wheel, and in any event it causes a serious loss of power.

The crank case should be designed so as to have as little space as possible and still give proper clearance to the moving parts therein. For high speeds it is better to have the inlet port in the crank case opened by the piston, although a poppet valve inlet placed on the by-pass port as near as possible the point where it enters the cylinder, will be found to work well, yet this adds a valve and spring and gives one point of trouble borrowed from a four-cycle motor and it is not needed; it also adds to the cost of manufacture.

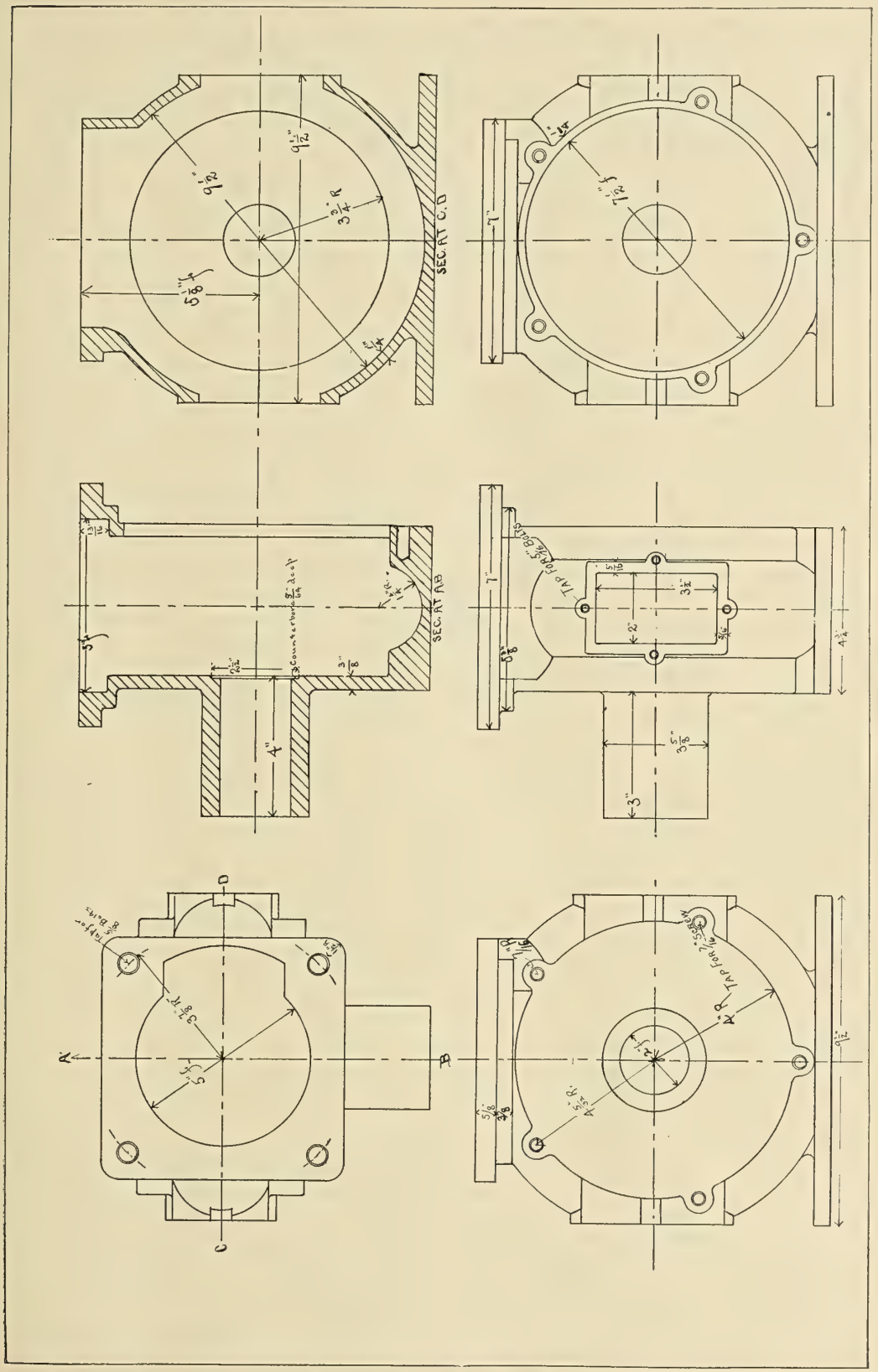
Herewith is given a complete set of working drawings for a 4 1-4 by 5-inch two-cycle motor that if well made and fitted as per instructions given above, will develop 6 brake horse power at 750 revolutions per minute. Later sketches will be given of special tools for doing the work right and attention will be called to the parts that require special care to produce good results.



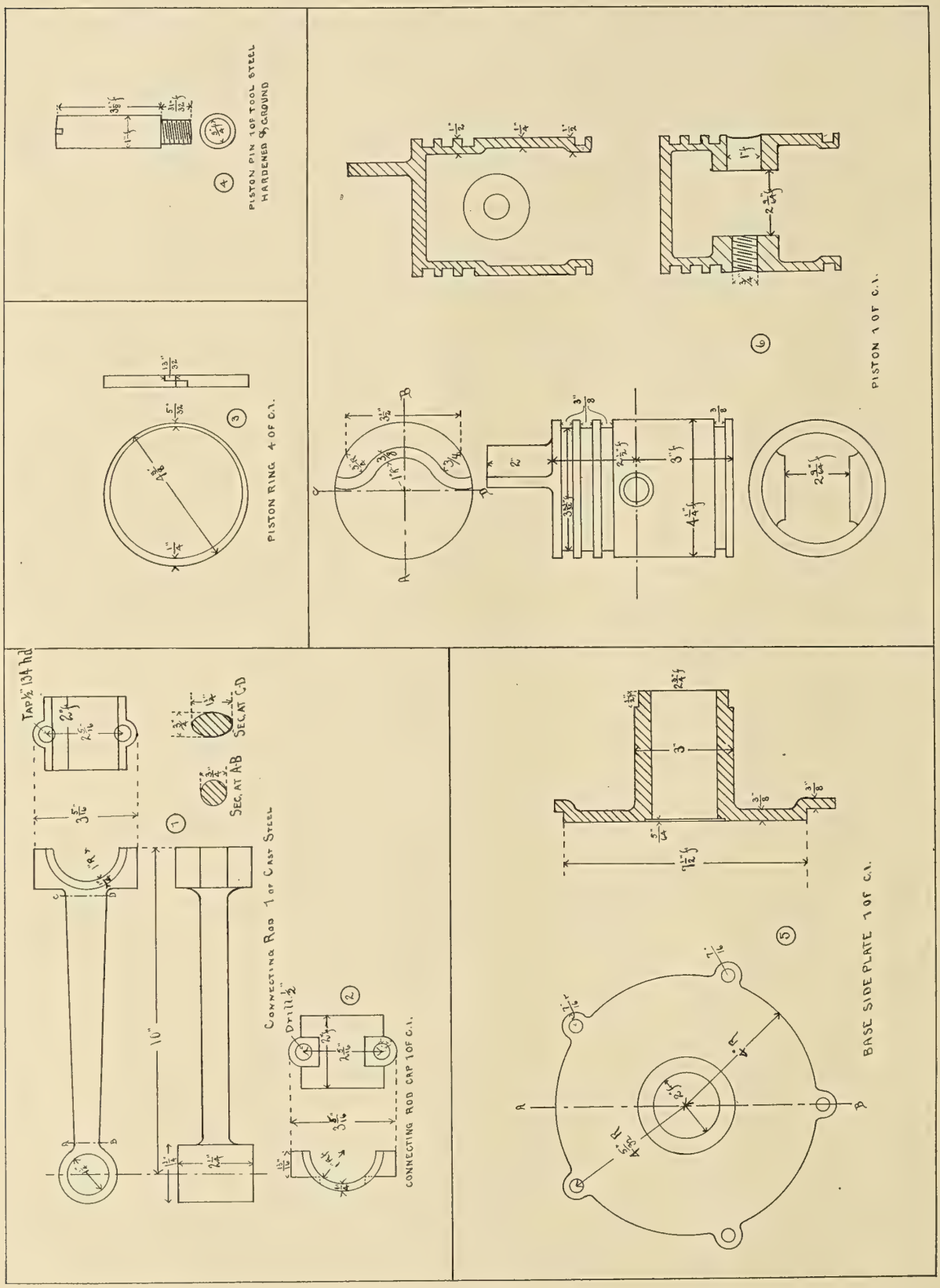
TWO-CYCLE MARINE MOTOR, 4 1-4 INCHES BORE BY 5 INCHES STROKE.



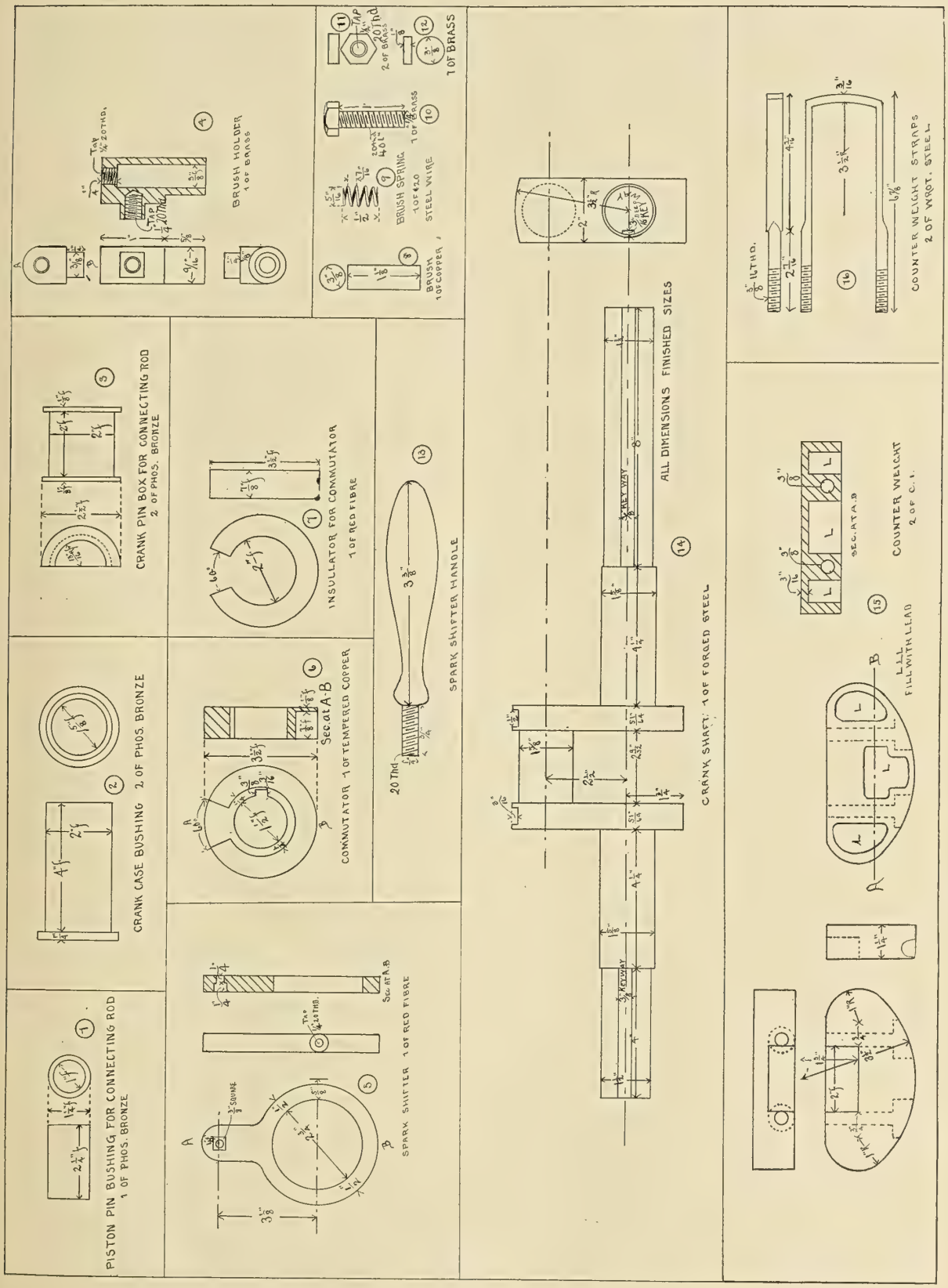
CYLINDER DETAIL, 4 1-4 BY 5 INCHES TWO-CYCLE MARINE MOTOR.



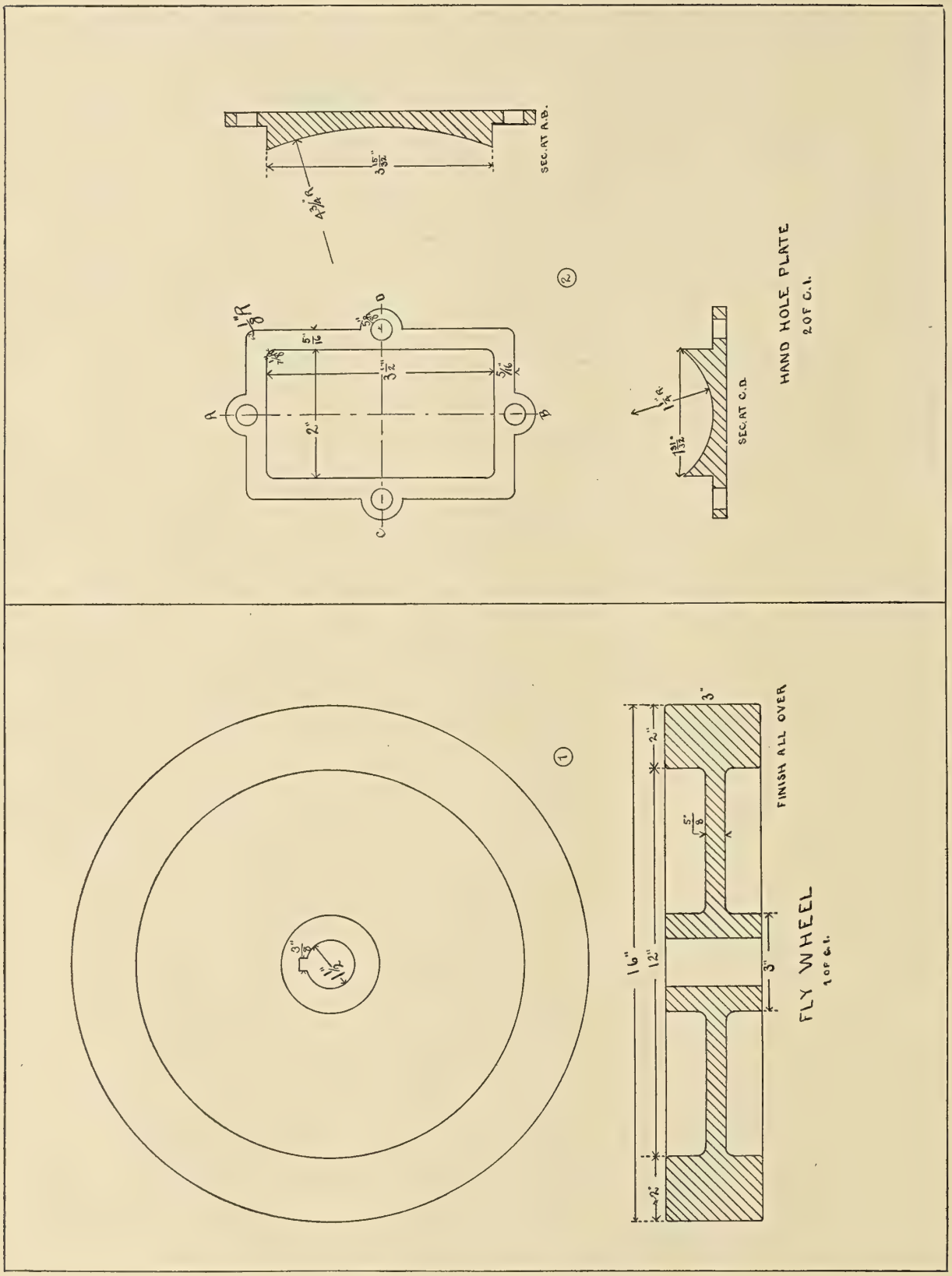
BASE DETAIL, 4 1-4 BY 5 INCHES TWO-CYCLE MARINE MOTOR.


PISTON PIN 1 OF TOOL STEEL HARDENED & GROUND
PISTON RING 4 OF C.I.
PISTON 1 OF C.I.
CONNECTING ROD 1 OF CAST STEEL
CONNECTING ROD CAP 1 OF C.I.
BASE SIDE PLATE 1 OF C.I.

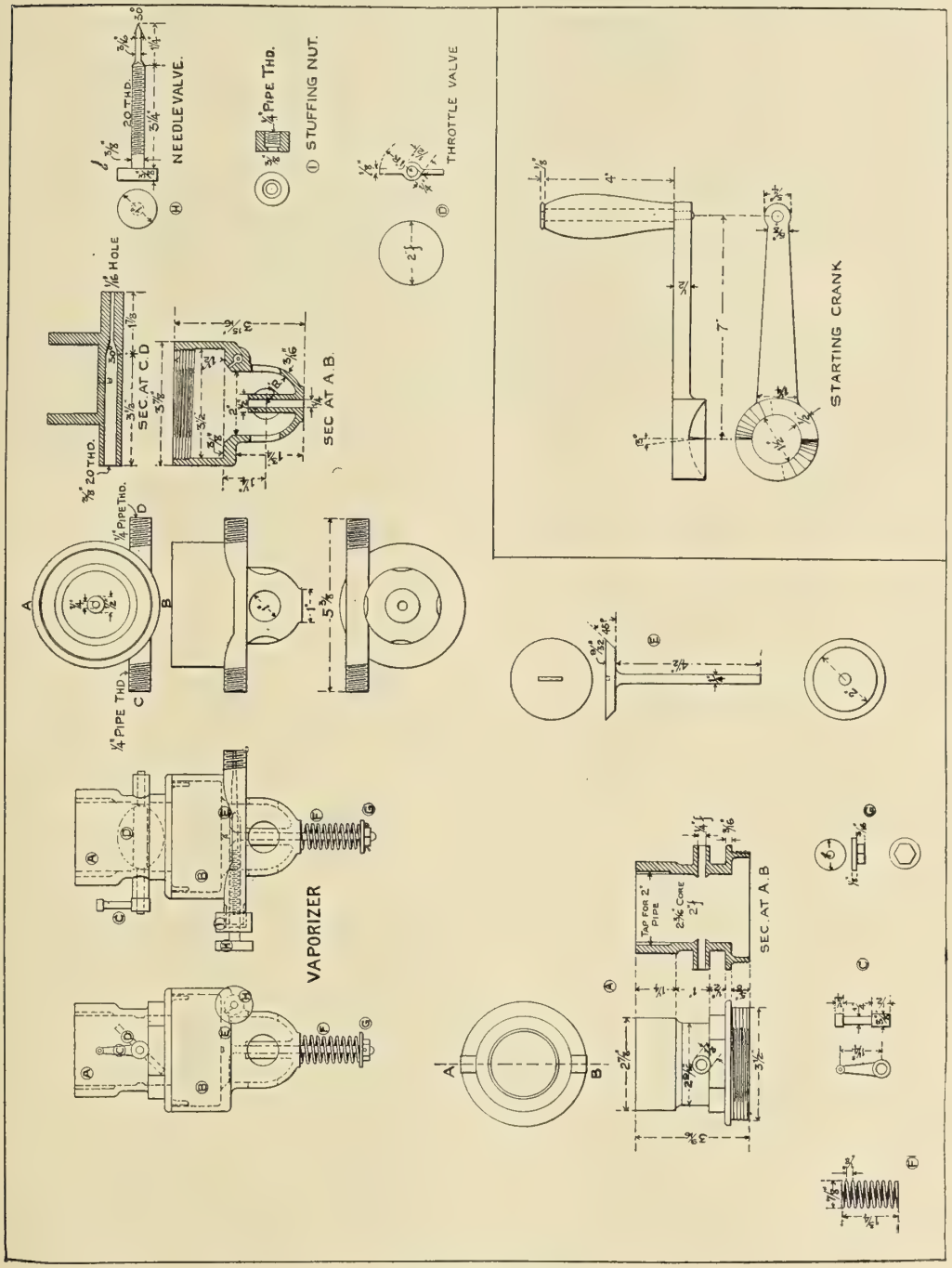
CONNECTING ROD, BASE SIDE PLATE AND PISTON DETAIL 4 1-4 BY 5 INCHES TWO-CYCLE MARINE MOTOR.



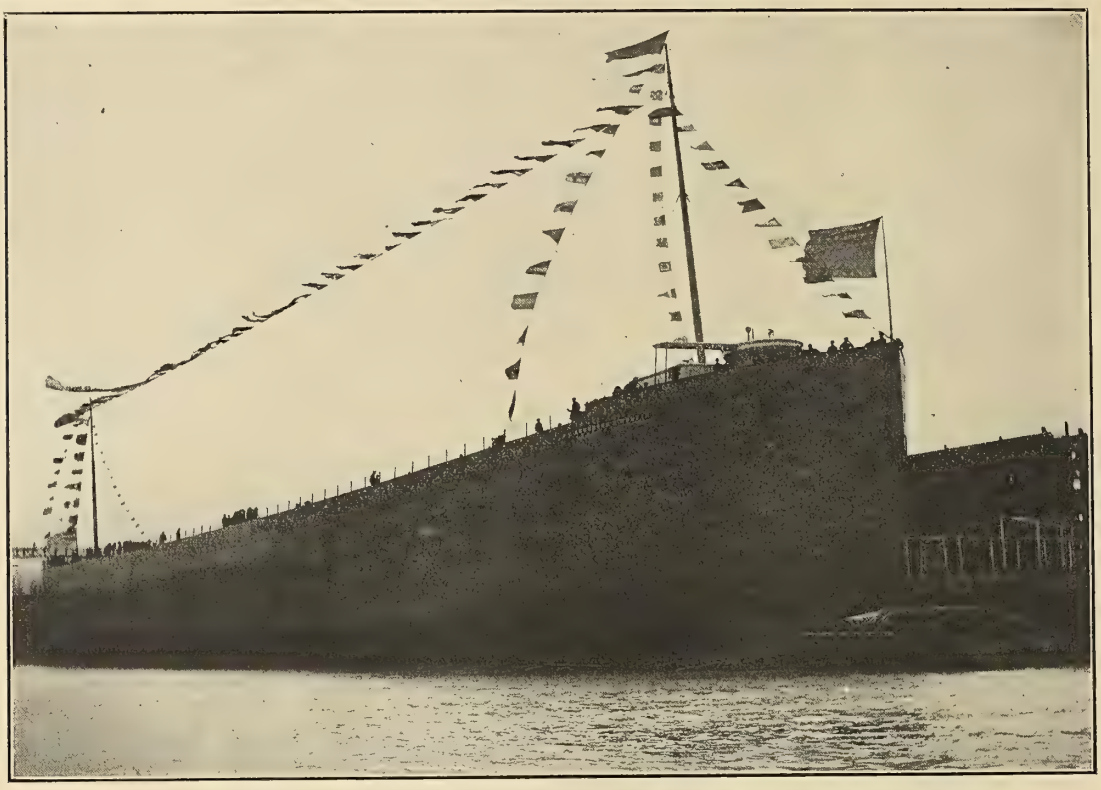
SHAFTING AND SUNDRY DETAILS, 4 1-4 BY 5 INCHES TWO-CYCLE MARINE MOTOR.



FLY WHEEL AND HAND HOLE PLATE, 4 1-4 BY 5 INCHES TWO-CYCLE MARINE MOTOR.



VAPORIZER DETAIL, 4 1-4 BY 5 INCHES TWO-CYCLE MARINE MOTOR.



LAUNCHING THE AUGUSTUS B. WOLVIN, THE LARGEST SHIP OF THE GREAT LAKES.

STEAMER AUGUSTUS B. WOLVIN OF THE GREAT LAKES.

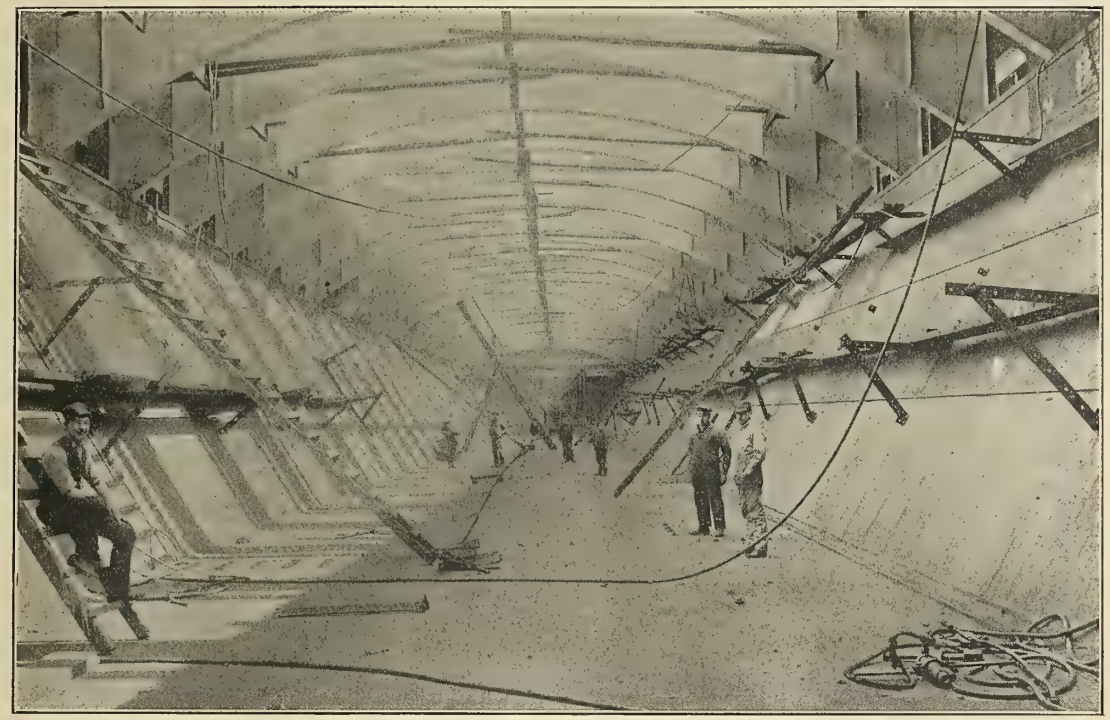
The *Augustus B. Wolvin,* the largest vessel ever built anywhere to navigate fresh water, was launched from the Lorain yard of the American Shipbuilding Company on April 9. The new steamer will run on the Acme Steamship Line of which Mr. Wolvin, for whom the vessel is christened, is a large owner. There are very few ocean vessels that are purely freight vessels that exceed her in dimensions, her length being 560 feet over all and 540 feet on keel, while the beam molded is 56 feet at the widest part, and a molded depth of 32 feet amidships.

The builders have incorporated in the design of this ship several new and interesting features, the principal one of which is probably the shape of the cargo hold. This is built in the form of a hopper, with sides that slope from the main deck down to the tank top and the ends built on the same slope. The hopper extends in one continuous length of 409 feet without bulkheads or divisions of any kind, and in width it measures at the top 43 feet, and at the bottom 24 feet. The space between the sides of the ship and the sides of the hopper is used for water ballast, so that the water ballast, as well as being in the usual double bottom underneath the hopper, extends up the sides to the height of the main deck stringer. This construction was adopted to accommodate the use of automatic clam shells in unloading the cargo and while it serves this purpose, it also serves to make a stronger vessel.

Another feature of the construction is the fact of the ordinary hold stanchions being dispensed with, and in their place a system of girder arches is substituted to support the upper deck as well as the sides of the vessel. There are thirty-three cargo hatchways on the spar deck, each one measuring 33 feet by 9 feet in the clear, and spaced 12 feet apart centers, so that it will be possible for the clam shells to unload the vessel entirely without any hand shoveling. These hatchways are fitted with a patented system of steel plate sliding hatch covers, operated by steam engines and shafting, so that no manual labor is required for the opening and closing of the hatch covers. The spar deck is continuous and flush from stem to stern, and the only erections on it are the pilot house and texas forward, and the coamings around the engine and boiler opening and dining room skylight aft.

The water ballast space is divided into numerous compartments by water-tight athwartship bulkheads fitted at intervals of about 60 feet, and the total ballast capacity is about 8,000 tons of water. The cubical capacity in the cargo hold of this immense vessel is about 500,000 cubic feet, which is equal to 401,000 bushels of grain, or to 12,500 tons of coal. On the spar deck are six 8-inch by 10-inch single drum engines, carrying each a steel wire mooring line for the usual mooring and warping purposes. In fact, steam has been used wherever possible to displace manual labor. There is a steam windlass fitted for handling the two 8,000-pound stockless anchors, and a steam capstan on the spar deck aft. The ship will be fully equipped with electric lights throughout and has duplicate plants, so that there will always be one to fall back on in case of the other giving out.

In the forward end of the vessel, immediately under the pilot house and texas, there are five state rooms



VIEW IN CARGO HOLD OF THE STEAMER AUGUSTUS B. WOLVIN, SHOWING INNER SIDE PLATING, DOUBLE BOTTOM AND ARCHED GIRDER BEAMS.

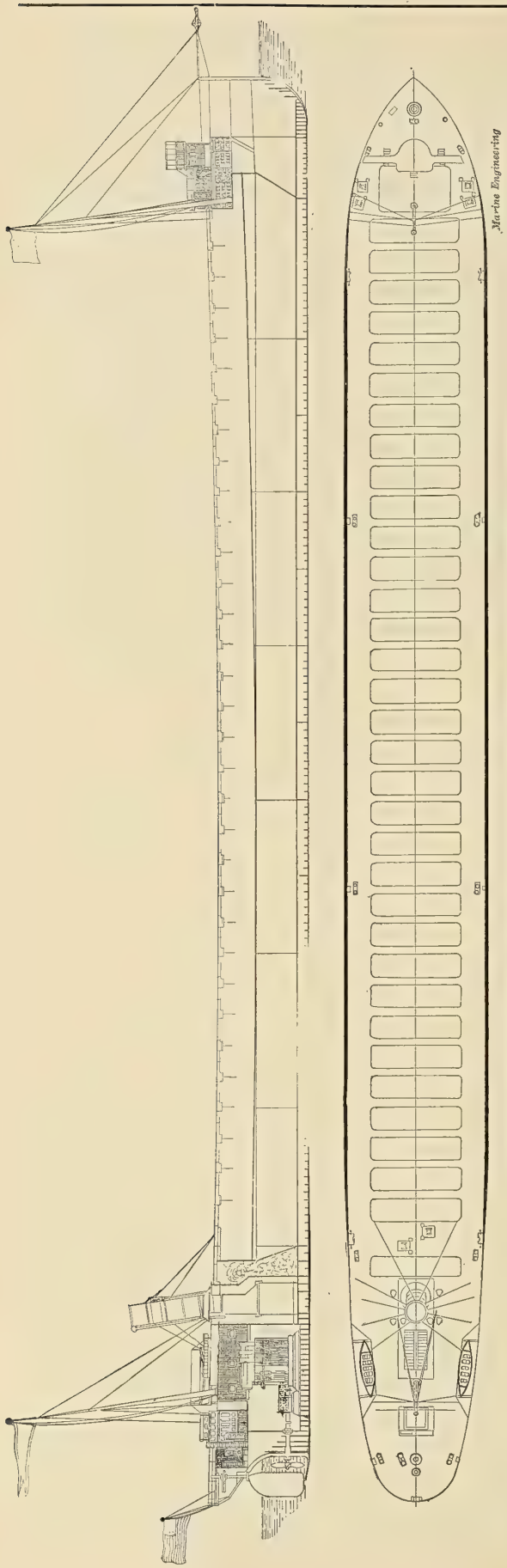
for owners and their families, also accommodations for their private galley, dining room and social parlor, and also two toilet rooms. They are entirely set apart from the crew's quarters and will be luxuriously furnished and fitted out. The ship's officers are accommodated on the deck immediately below the owner's quarters, and the engine room officers are quartered alongside of the engine at the after end of the vessel, where is also located the kitchen, dining room and mess room for the crew.

The propelling machinery, as is usual in Lake vessels, is located in the extreme after end of the boat. The main engine is of the quadruple four-crank type, with cylinders 18 1-2, 28 1-2, 43 1-2, and 66 inches diameter, each having 42-inch stroke of pistons, and they are designed for an indicated horse power of 2,000 when making 80 revolutions per minute. The cylinders are arranged from forward in the following order: High pressure, first intermediate, second intermediate, and low pressure. The high pressure is fitted with a liner secured in the usual way. The valves of the high, first and second intermediate are of the piston type, placed in front of their respective cylinders, and driven by Joy radial valve gear. The low pressure cylinder is fitted with a double ported slide valve on the after end, operated by double bar Stephenson link motion.

The bed-plate is of the girder type, of box section, in two pieces, bolted together, and has five main bearings lined with white metal. There are four back and five front cast iron columns, the former acting as guides for the crossheads. The piston rods are of steel 5 3-8 inches diameter, and the connecting rods of hammered iron 9 feet long between centers, with wedge adjustment at top, and T ends with bolts at bottom. The crossheads are of cast steel, keyed to piston rods and fitted with steel crosshead pins, secured with double taper and nut. The slippers are of bronze of large surface and easily adjustable. The crank shaft which with its four cranks is built without couplings, is 12 1-2 inches diameter. The crank pins are each 12 1-2 inches diameter by 13 1-2 inches long. The thrust is of the "horseshoe" type with six go-ahead collars and five backing. The engine is fitted with a direct acting steam, and a hand, worm reversing gear, also a steam turning gear at aft end of thrust shaft. The propeller is four-bladed cast steel, of sectional type. The outboard bearing is 13 inches diameter by 4 feet 8 inches long, filled with lignum vitæ.

The boilers, two in number, are of the Babcock & Wilcox type, and placed with a 12-foot space between them, to fire athwartships. The working pressure is 250 pounds per square inch, and the steam is superheated, the superheater being placed on top of boiler proper. The boilers are fitted with the mechanical stoker built by the Duluth Stoker Company, the coal being fed into hoppers, passing from thence on to traveling grates, the ashes being deposited at the back of boilers and discharged overboard by means of steam driven elevators. The boilers are fitted with Ellis and Eaves induced draft, having two 7 feet 6 inches diameter fans driven by double 6-inch by 5-inch high-speed engines.

To purify and heat the feed water before reaching the boilers, two Learmonth purifiers are fitted, also a large heater into which all the auxiliaries exhaust. There are the following auxiliaries in the engine room, the pumps, all being of the Blake type: One vertical cross compound simplex air pump; two horizontal cross



INBOARD PROFILE AND DECK PLAN OF THE GREAT LAKES FREIGHT STEAMER AUGUSTUS B. WOLVIN.

compound simplex ballast pumps; one horizontal compound duplex feed pump; one horizontal duplex pony pump; one horizontal duplex bilge pump; one horizontal duplex cooler pump. Two General Electric generating sets of 15 k. w. capacity each for electric lighting. One Globe steam steerer, and one Sturtevant fan with attached engine for ventilating purposes.

The coal bunker is fitted in front of the boiler room and has capacity for about 350 tons of coal. In every respect the vessel has been fitted out and built to meet the most modern requirements of the Lake service and there is not the slightest doubt but what she will fulfil every anticipation made of her.

Lehigh University.—The Registry of the Lehigh University, South Bethlehem, Pa., just issued, shows the attendance of 615 students from 24 cities and 10 foreign countries. Among this number are 174 studying the course of mechanical engineers, in which marine engineering is offered as an option during the junior and senior years.

Monthly Shipbuilding Returns.—The Bureau of Navigation reports 91 vessels of 25,866 gross tons built in the United States and officially numbered during the month of March, 1904. The largest steel steam vessels included in these figures are: *Manchuria,* 13,638 gross tons, built at Camden, N. J.; *Umbria,* 4,803 gross tons, built in Cleveland, Ohio.

MARINE ENGINEERING DATA CARD. MAY, 1904.

NAME—Augustus B. Wolvin. NATIONALITY—American. TYPE—Great Lakes freighter.

LAUNCHED—1904. BUILDERS—American S. B. Co. OWNERS—Acme Steamship Line.

Length over all.....560 ft. 0 ins.
" keel.....540 " 0 "
Beam.....56 " 0 "
Depth.....32 " 0 "
Load draft, forward and aft.....21 " 0 "
Ballast.....8,000 tons (short) fresh water
Cargo capacity.....500,000 cu. ft.
Dead weight, carrying.....12,700 (short) tons
Coal bunker.....350 tons
Engine: Number.....one
Type.....quadruple
Cylinder diam.....18 1-2, 28 1-2, 43 1-2, 66 ins.
Stroke.....42 ins.
R. P. M., designed.....80
I. H. P.....2,000
Crank shaft, diameter.....12 1-2 ins.

Propeller: Diameter.....14 ft. 6 ins.
Pitch.....14 " 6 "
Area, projected.....61.64 sq. ft.
Boilers: Number of.....two
Type.....Babcock & Wilcox water tube
Working pressure.....250 lbs.
Tubes, size.....4 ins.
Steam drums.....one each
Mech. stokers.....Duluth
H. S., two boilers.....5,500 sq. ft.
G. S., " " .....150 " "
Induced draft.....Ellis & Eaves

PACIFIC STEAMSHIP QUEEN ARRIVING AT SEATTLE DAMAGED BY FIRE AT SEA.

Fourteen Lives Lost in a Fire on the Steamship Queen.

Fire swept the steamship *Queen*, of the Pacific Coast Steamship Company, off Tillamook Light, on the Coast of Oregon, early in the morning of February 27, 1904, and fourteen lives were lost. Ten who died were members of the crew, burned or drowned, while four were passengers. The flames were discovered in a stateroom on the port side of the saloon deck by the night watchman at 4.30 A. M. Word was at once carried to Capt. Cousins the captain sounded the fire alarm and summoned the crew on deck to fight the flames, which rapidly gathered headway, until the entire after part of the ship was a seething mass. Life preservers were distributed among the one hundred and forty passengers on board, and when it appeared that the ship could not be saved the captain gave the order for clearing away the boats, and the four boats on the weather or port side were lowered and three of the crew placed in each boat to bring it around to the lee side. Then the boats on the starboard side were filled with women and children and lowered. All got away safely except the last one which got under the guard and was smashed and capsized; the other boats went to the rescue of the passengers, and it is worthy to call attention that only one passenger was drowned, the others being members of the crew. There were about sixty people in all lowered into the different boats. The boats were in the open until 8.30 o'clock, when, as it was believed the fire was under control, the whistle of the ship was sounded for them to return, and at 10.30 all were on board, and the *Queen* proceeded on her journey to Port Townsend. Three of the crew who were asleep in the glory-hole were burned to death in trying to get out.

A heavy sea was running at the time of the accident and a small gale blowing from the southwest. The origin of the fire appears to be unknown, but it gathered force very quickly, and it appeared that the ship would have to be abandoned. All on board speak in highest praise of the captain and his crew for the splendid work in fighting the flames and looking after the passengers. There was no confusion among the crew or passengers. Smoke filled the engine and boiler rooms, so that it was with the greatest difficulty that engineers could remain on duty at the pumps. A list of the officers of the *Queen* is as follows: Captain, N. E. Cousins; first officer, Geo. E. Zeh; second officer, I. N. Rees; third officer, W. Jackson; fourth officer, F. Meyers; chief engineer, W. J. McCreedy; first assistant, W. E. Anderson; second assistant, C. Harland; third assistant, G. C. Bronson; purser, F. R. Wetmore.

The *Queen* was on her 505th voyage. She is a steel ship, built at Cramps' yard in 1882, and is 331 by 38 1-2 by 21.2 feet. She is driven by a set of triple-expansion engines. The fire completely destroyed, as shown in the picture, the after cabins and deck, but it is stated that the hull plating was intact. She is now in dock and has been surveyed.

Cunard Liners.—The Cunard Company has announced its decision to install steam turbines on the two projected 25-knot express steamers. Four shafts will be fitted—a turbine on each shaft.

MERCHANT CRUISERS AND STEAMSHIP SUBSIDIES.*

BY THE RIGHT HONORABLE LORD BRASSEY, K.C.B., D.C.L.

The Institution of Naval Architects is essentially a professional organization. It sometimes deals with administrative questions, and such questions are pressing at the present time. There will be little opposition to naval expenditure on the ground of excess. But we are inconsistent. There may be murmurs at increase of taxation. In the conditions, with which we have to deal—public revenues less elastic, and consols showing a heavy fall in price—it is for those who are most deeply convinced of the necessity for maintaining a powerful navy carefully to consider every means by which efficiency can be combined with economy.

We discussed auxiliary cruisers, or scouts, at Glasgow. Then, as now, the need for care in the application of resources, however ample, was recognized: Such care is even more imperative to-day.

The Navy estimates, lately laid before Parliament, have reached an unprecedented figure. Looking back over ten years, the votes have grown from 19,031,000*l.* in 1895-6 to 36,880,000*l.* for 1904-5. To this total we have to add the cost of works and fortifications in part provided for by loan, in part charged on Army estimates.

Let us trace the comparative growth of expenditure as given in the columns of *Engineering,* in a recent issue. Our total Navy votes for 1893-4 were 14,500,000*l.*, as against a total for France, Russia, and Germany of 19,750,000*l.* The votes for the three Powers are now 35,000,000*l.* The three Powers have increased their votes by 15,000,000*l.* a year The British expenditure has increased by over 22,000,000*l.* Our expenditure for manning and the maintenance of ships in commission far exceeds that of the three Powers. As our Reserves grow we may reduce our numbers for active service.

If we turn to new construction, the branch of our subject with which this Institution is alone in any way concerned, we have barely maintained a two-power standard. Expenditure on shipbuilding has largely increased in Russia and Germany. In France it has not diminished. Between 1897 and 1902 the expenditure in shipbuilding for the British Navy was barely equal to the combined expenditure of France and Russia.

The amounts to be voted must be determined by Parliament upon the advice of the Admiralty, and with adequate information as to the policy of foreign countries. In the appropriation of expenditure administrators responsible to Parliament must depend on the advice of experts.

Let us see how we stand in the relative strength of our battleships and cruisers. The well-known "Taschenbuch der Kriegsflotten," compiled by Lieutenant Brenco Weyer, gives a forward statement for 1908:—

Battleships: Less than 25 Years from Date of Launch.

	Ships.	Aggregate Tonnage.
Great Britain	59	880,000
Russia	29	348,000
France	29	325,000
Germany	23	265,000
Total	81	938,000

Cruisers: Less than 20 Years from Date of Launch.

	Ships.	Aggregate Tonnage.
Great Britain	71	686,000
Russia	17	131,600
France	28	251,900
Germany	12	91,500
Total	57	475,000

The tables show that our shipbuilding should be concentrated more largely on battleships, and their indispensable auxiliaries—the destroyers. Armed cruisers are necessary for the protection of commerce. They must be regularly-built vessels of war. Ships for scouting should be obtained as far as possible from the mercantile marine. Speed and coal endurance are the essential qualities. No vessels of war have as yet been equal to the ocean liners. The German ships have an ocean speed of 23 1-2 knots. The *Lucania* and *Campania* of the Cunard, and the *Oceanic* of the White Star Line, steam 21 knots. The *Teutonic* and *Majestic* steam 20 knots; the *Umbria* and *Etruria* 19 knots.

For keeping open lines of communication, Lord Charles Beresford told the Select Committee on Steamship Subsidies that the ocean liners are absolutely wanted. There were no other ships which could do the work required as well as the ocean grayhounds, built for speed in any weather.

Foreign countries look on their fleets of postal vessels as indispensable auxiliaries to their navies. They are liberal in subsidies. In proportion to the tonnage of their mercantile navies and the requirements of their fleets, they are more liberal than the British Government. The total annual payments, as reported by the Committee on Steamship Subsidies, are as under:

	£
British mail subsidies	756,580
Additional payment to Cunard Company	150,000
Admiralty subsidies	77,813
	984,393
French subsidies (including bounties for shipbuilding and navigation)	1,787,271
Russian subsidies	364,756
Austrian subsidies	318,983
Japanese subsidies (approximate)	750,000

Passing from subsidies for the ocean mails to payments for mercantile cruisers, the latest information is

*Paper read before the Institution of Naval Architects, London, March 23, 1904.

Turbine Steamers in Germany.—Two turbine steamers are now being built in Germany, one at Danzig and one at Kiel. The first is an Imperial Navy cruiser of about 2,000 tons gross and 10,000 horse power with four screws, and the other is a passenger steamer of about 500 tons gross and 1,200 horse power with three screws.

given in a return recently presented to Parliament, on the motion of Earl Spencer. The total amount which had been paid for subventions is 712,376*l.*, the earliest agreement being dated May 14, 1888. The total number of ships subsidized is twenty-eight, including the *City of New York* and the *City of Paris,* which have since passed under the flag of the United States. The original agreements with the Admiralty did not provide effectively against the transfer of the subsidized vessels to foreign flags. Nine ships only in the list have a speed of 19 knots and over. The ships employed as the scouts or look-out vessels of the fleet should, it is reasonable to assume, have a speed at least equal to the sea-speed of a first class cruiser.

If the engagements had been such as to secure that no subsidized vessel could hoist a foreign flag without the consent of the Admiralty, and all the ships had a sea-speed of 20 knots, the payments might not be regarded as unduly onerous. The expenditure on subsidies for the twenty-eight ships does not exceed the cost of a single cruiser of the County class, of 9800 tons, with a speed of 23 knots on the measured mile, but with a coal capacity of not more than 800 tons. The cost of a second class cruiser, of 5880 tons, measured mile speed 21 knots, and coal supply 500 tons, rises as high as 437,000*l.* For the four first class cruisers of the *Black Prince* class, recently designed by Mr. Watts, the estimated cost has advanced to a total of 1,138,606*l.* The number of ships of this formidable type must be limited.

It is essential that the Admiralty should have at their disposal auxiliaries for scouting duties. Ships of exceptional speed are necessarily costly, and the return to the shipowners is doubtful. The fast and powerful liners under the German flag belong to fleets far exceeding in numbers and tonnage those under the British flag. The Cunard Company's fleet consists of ten ships only, of which four are the well-known *Campania, Lucania, Etruria,* and *Umbria.* The Hamburg-American Company, to which the *Fürst Bismarck* and *Deutschland* belong, are the owners of no less than thirty-two ships, of which two only can be described as small vessels. The Norddeutscher Lloyd, owners of the *Kaiser Wilhelm II., Kronprinz Wilhelm, Kaiser Wilhelm der Grosse,* and *Grosser Kurfürst* has a fleet of seventy-two ships, of which five only are small vessels. These German companies have powerful resources. It may be for their advantage to run some ships at a loss, with a view to give a name to the entire fleet under their flag. This, therefore, is a point of consideration whenever we come to deal in a practical way with the requirements of the British Navy in regard to mercantile auxiliaries.

It is desired in the present paper to urge a more liberal expenditure on subsidies to fast ocean services, and thus to provide the fleet, at the lowest cost, with a reserve of ships for scouting duties. Such ships may serve another purpose. Practical instruction in engine-room and stokehold duties for newly-entered men in the Royal Navy was formerly obtained in the transport service. It may be given, and at less cost, in the auxiliary vessels of the Navy.

We have already established mail services to the Cape, to the East, and to Australasia. We may improve those services. The ships may be capable of higher speeds. They may be fitted with portable armor, and with bulkheads for more minute internal subdivision when employed as scouts. We may establish new lines, such as those so much desired in Canada, to connect the Dominion with Australia and the United Kingdom; and while fostering trade, providing scouts for the fleet, and increasing the means of training for the engine room complements of the Navy, and more especially for men on whom we may rely as reservists, we may do something effective in a cause which we all have at heart. Swift communications are a bond of empire. The establishment of a fast service between the nearest British port and Halifax was recommended to the Select Committee on Steamship Subsidies by Senator Drummond, of Montreal, on the ground that he considered a fast line of communication of imperial importance.

Addressing the Institution of Naval Architects, I may once more ask these questions: Is it possible to build ocean liners, able to carry portable armor, and fitted for additional internal bulkheads, without increasing the cost unduly, or impairing efficiency for peace service? Is it feasible to look for reduction in the cost of cruisers, specially designed as vessels of war?

DISCUSSION.*

Professor Biles was the first speaker. He pointed out that the paper was a natural sequel to that read by the author in Glasgow, which resulted in the formation of an Admiralty Committee to consider the question of mercantile auxiliaries. The speaker was appointed a member of that Committee, the reference for which was confined to high speed vessels, and an attempt was made to relate speed to subsidy. He had put a rider to the report, and considered that the Committee had not interpreted the reference as widely as might have been done; other vessels, having speeds short of the highest, such as 16 to 20 knots, might, he thought, have been taken into consideration. He assumed that Lord Grassey had such vessels in his mind when he said that the fast line of communication was of imperial importance; that, the speaker thought, was the key to the situation. The other view was that vessels which could maintain communication on our ocean routes would be able to act as scouts. The question arose as to what constituted a scout. Any vessel built for the Navy at present as a scout might be taken as useless for mercantile purposes; but it by no means followed that ships built for mercantile uses would be unserviceable as scouts. In 1894 he had read a paper at Southampton, in which he endeavored to show that vessels which would be useful for earning money could be so built as to be of service in warfare. He had there indicated a system by which protection could be put on to mercantile ships for warlike purposes. [(See *Engineering*, vol. lviii., pages 402.) It will be remembered that Professor Biles proposed constructing the sides of vessels with recesses which could be filled with wood in time of peace, but would take armor plates when needed for warlike purposes, coal bunkers being placed at the sides for increase of protection.] He

* This discussion is taken from *Engineering*, London, April 1, 1904.

would point out that if vessels of the very highest speed were needed, it would not be possible to carry portable armor; ships of this nature were not used for cargo purposes, the whole displacement being required for the speed, and so there would be no margin for the additional weight of armor. It would not be difficult, however, to translate ships of 18 to 20 knots, which carried cargo, into armored cruisers. Lord Brassey had addressed to members of the Institution two questions: "Is it possible to build ocean liners able to carry portable armor, and fitted with additional bulkheads, without increasing the cost unduly, or impairing efficiency for peace service? Is it possible to look for reduction in the cost of cruisers specially designed as vessels of war?" The problem of cost had been referred to in his paper. He would answer Lord Brassey by saying that what he asked was possible, and he thought that subsidies to meet the case on the lines which were referred to were desirable. The Government would be quite justified in paying such subsidies, in view of the advantages to be obtained.

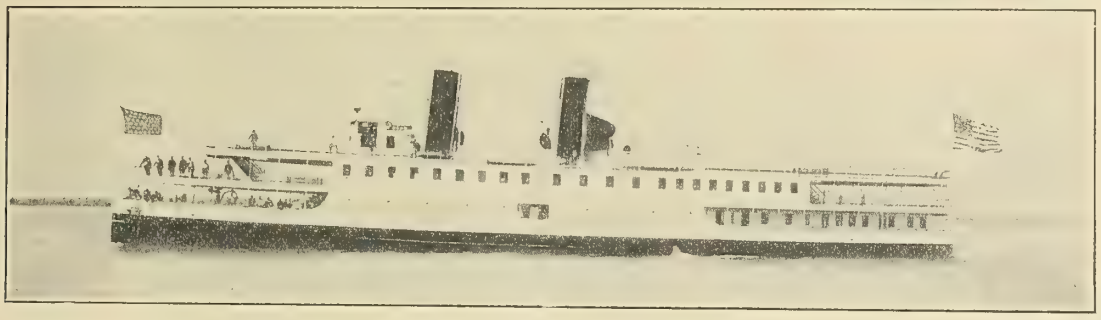
Admiral Sir Digby Morant pointed out that probably in war time most of the ships that were now subsidized would be required to keep open the communications with foreign countries, and, therefore, they would not be available for scouts. These fast liners only carried coal for about six days at their highest speed, and there was no part of the displacement devoted to cargo which could give place to coal. He thought there would be very great difficulties in making a ship, fit for ordinary mercantile duties, suitable for portable armor. Some years ago he was ordered to fit out certain merchant ships for naval purposes. He provided protection by an arrangement of the coal bunkers, but in those times there were not in existence the fast cruisers we now have. That defect had been remedied, and we now had warships that were capable of very high speeds, and special scouts were being built. Under these circumstances he doubted whether any advantage would be obtained by taking mercantile vessels as additional cruisers for the fleet. For war purposes no ship without protective armor could live through a fight.

Admiral Fitzgerald was also one of the members of the Committee which had sprung out of Lord Brassey's paper, and his opinion was that ships fit for scouting purposes would not be suitable for mercantile work; it would be far better to build ships specially for the purpose. It is true Lord Charles Beresford had said that no ship would form a better scout than an ocean grayhound, but at that time the fast ships we now have did not exist. There seemed to be some misapprehension as to what were scouting duties, and he would point out that it was only necessary for these vessels to go out and bring back news to the fleet, having sufficient armament to fight destroyers, or other ships smaller and faster than themselves. He considered the second-class cruisers of no use. He did not believe that the system of having portable armor was one that could be relied upon, as it would take a long time to put on the plates. The armor would be kept on shore, and at the outbreak of war it might not be near the ship for which it was intended. The introduction of wireless telegraphy had rendered it less necessary that there should be a large number of scouts, and it would be noticed that in Far Eastern waters the Japanese were working without scouts. On the whole, he thought it would be better to spend money on building cruisers than on subsidizing merchant vessels.

Admiral Sir Edward Freemantle did not entirely agree with some of his brother officers, but was inclined to take the side of Lord Charles Beresford. He considered no other ship so good as an ocean grayhound for scouting purposes. If Admiral Fitzgerald could get one of the scouts across the Atlantic and back again at full speed, then it might not be necessary to have recourse to these fast liners; but he thought that could hardly be done. Supposing the fleet were in the West Indies when war was declared, would it be possible for it to get back at 18 knots the whole way? Those who thought such a thing possible would do well to look at the report of the last manœuvers. The gallant admiral did not appear to think favorably of the armored cruisers. He pointed out that some years ago we were not building any, but now we appeared to have got them on the brain. He agreed with Lord Charles Beresford that if he were in command in the Atlantic, and wanted to send to the West Indies, he would have grave doubt if a cruiser could make the voyage satisfactorily; but if he had such a vessel as the *Campania,* he would have confidence that she would make the voyage at 21 knots. The man-of-war could not keep up the speed attained on the measured mile within 3 or 4 knots for a 1,000 miles' run. He would therefore have ocean liners as long-distance scouts. He was not in favor, however, of arranging vessels for taking the armor in the way suggested by Professor Biles; these portable arrangements did not work well. He remembered one case—that of the *Shannan*—in which the vessel had an adjustable ram which could be shipped or unshipped in times of peace or war.

Professor Biles, referring to what had been said by the last speaker, thought that the discussion should not close without it being pointed out that vessels of the length of scouts should not be expected to cross the Atlantic at 20 knots. The *Deutschland* was 680 feet long, and made a speed of 23 1-3 knots. It would be necessary to have a vessel at least 500 feet long to make 20 knots continuously at sea.

Lord Brassey, in replying to the discussion, said that the position of this country was perfectly plain. We had reached a scale of expenditure for the Navy which was enormous. The last estimates gave a total of not far from 37 million sterling, of which over 18 millions were in the shipbuilding vote. Yet it was not possible to cut down the expenditure on battleships, and the money devoted to armored cruisers was not excessive. It yet remained that we wanted more scouts. Admiral Fitzgerald said: "Build more of these vessels;" but that would mean an increase of expenditure which it was difficult to contemplate. We were all ready to vote large appropriations, but there was a limit to the possibility of taxation, and that was the reason he had offered a suggestion to make use of auxiliary vessels in war time.



STEAMBOAT PENN OF THE BALTIMORE & PHILADELPHIA STEAMBOAT COMPANY.

STEAMERS OF BALTIMORE AND PHILADELPHIA STEAMBOAT COMPANY.

With the opening of the summer excursion season, the steamers *Penn* and *Lord Baltimore* will be placed on the Baltimore-Philadelphia service of the Ericcson Line. These two fast vessels were built at the Harlan & Hollingsworth Company, Wilmington, Del., and were brought out for this line in the summer of 1903. The route from Philadelphia to Baltimore is first down the Delaware river as far as Delaware City, and thence through the Chesapeake and Delaware canal to the Elk river at the head of Chesapeake bay. It is an interesting route throughout, especially through the canal which has to be entered and left through locks. The new boats make the trip by daylight.

MARINE ENGINEERING DATA CARD. MAY, 1904.

NAMES—Penn and Lord, Baltimore. NATIONALITY—American. TYPE—Passenger steamer.
LAUNCHED—1903. BUILDERS—Harlan and Hollingsworth. OWNERS—Ericcson Line.

Length over all.....203 ft. 0 ins.
" between perps.....190 " 0 "
Beam, molded.....23 " 5 "
Depth, " .....12 " 0 "
Tonnage, net.....288
Draft, load.....for'd, 8 ft. 0 ins. aft, 9 ft. 4 ins.
" light.....5 " 6 " 8 " 4 "
Displacement load, in tons, 9 ft. mean draft, 615 short tons
Engines: Number.....1
Type.....4-cylinder, triple
Cylinder diameters.....21, 32, 35 and 35 ins.
Stroke.....24 "
Valves, 1, piston on H. P. 12 1-2 ins. diam.; 2, piston on I. P. 12 1-2 ins. diam.; slide on L. P.
Shafting, crank, thrust, diam., 9 1-4 ins.
Line.....9 1-8 "

Shafting, propeller.....9 1-2 ins.
Collars on thrust.....10
" diameter.....16 1-4 ins.
Propellers, diameter.....8 ft. 0 ins.
Propeller: Pitch.....10 " 6 "
Diameter.....8 " 0 "
Area, developed, 42 per cent. of disk, 21 " 0 "
Blades, number and material, 4, manganese bronze
Framing.....Cast iron inverted Y-back, open front, steel stanchions
Boilers:.....4 Almy water tube
H. S., total.....6,879.2 sq. ft.
G. S.....199.32 " "
Pressure.....200 lbs.
I. H. P., in service.....2,000
Rev., " " 200
Speed, " " ...20 miles per hour

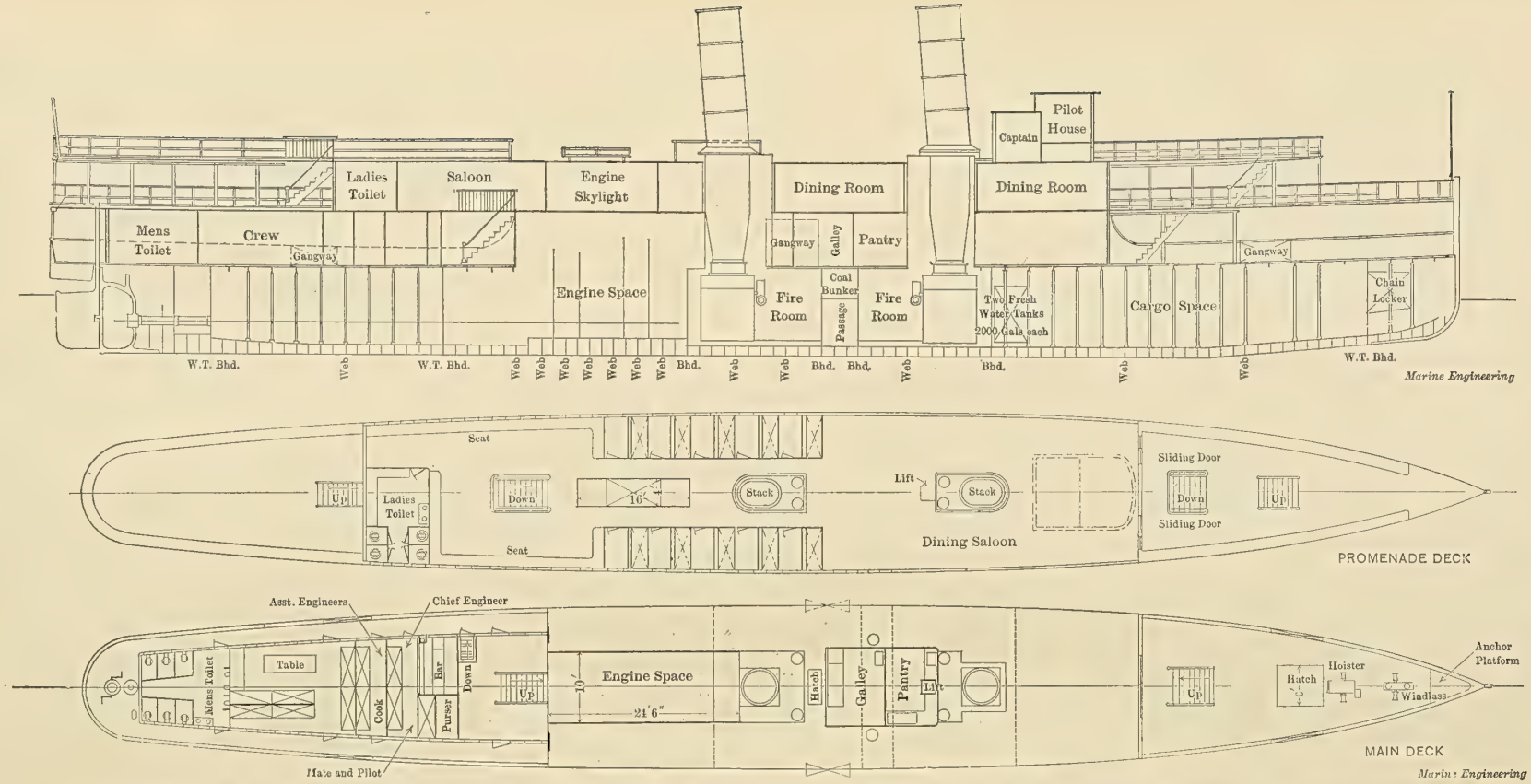
The general dimensions of the vessels are: Length over all, 203 feet; beam, molded, 23 feet 5 inches; draft, 9 feet; speed, 20 statute miles. Other details will be found in the data card. The two vessels are built of steel and are identical in every particular; the construction is shown on the midship section diagram on page 235. There are four water tight bulkheads up to the main deck. On the main deck forward is an open space for handling lines and what little freight is carried is placed here and in the forward hold. The boats are distinctly passenger vessels. A Williamson hoisting engine is placed forward and there are also two cranes for handling light cargo from the lower hold.

Midships the side of the hull is steel plated between the main and upper decks, for stiffness and for the prevention of fire. Steel casings are carried up to the upper deck around the engine and boiler room inclosures. On the main deck aft are the purser's quarters, men's smoking room and toilet accommodations for the officers and part of the crew, the latter being under the after end of the saloon deck. The galley and pantry are on this deck forward of the aft smoke stack, and are well equipped. The plumbing throughout the boat is of the latest sanitary pattern, and there is an abundant water supply.

The dining saloon is at the forward end of the house on the upper deck. It is well lighted from skylight above and with windows at sides and at forward end. On each side of the house are five large comfortable state rooms for the convenience of invalids and those desiring privacy. The dining room has accommodation for seating 76 people at one time, and the food is brought up from the pantry below through an elevator shaft. At the after end of the house is a comfortable saloon with a cozy corner and seats for a number of passengers. A large deck space is provided on this deck both forward and aft of this house, seats being fitted around the rail. In all 786 passengers are allowed to be carried according to certificate.

The hurricane deck is carried from well forward to the stern and presents an almost unbroken promenade for the passengers. The pilot house and captain and mates quarters are just forward of the funnel. A steam steering gear of the Williamson pattern is provided for rapidly handling the vessel, while for emergency hand gear may be used.

Large power has been put into each of these light draft boats, consisting of one four-cylinder triple expansion engine developing about 2,000 I. H. P., driving

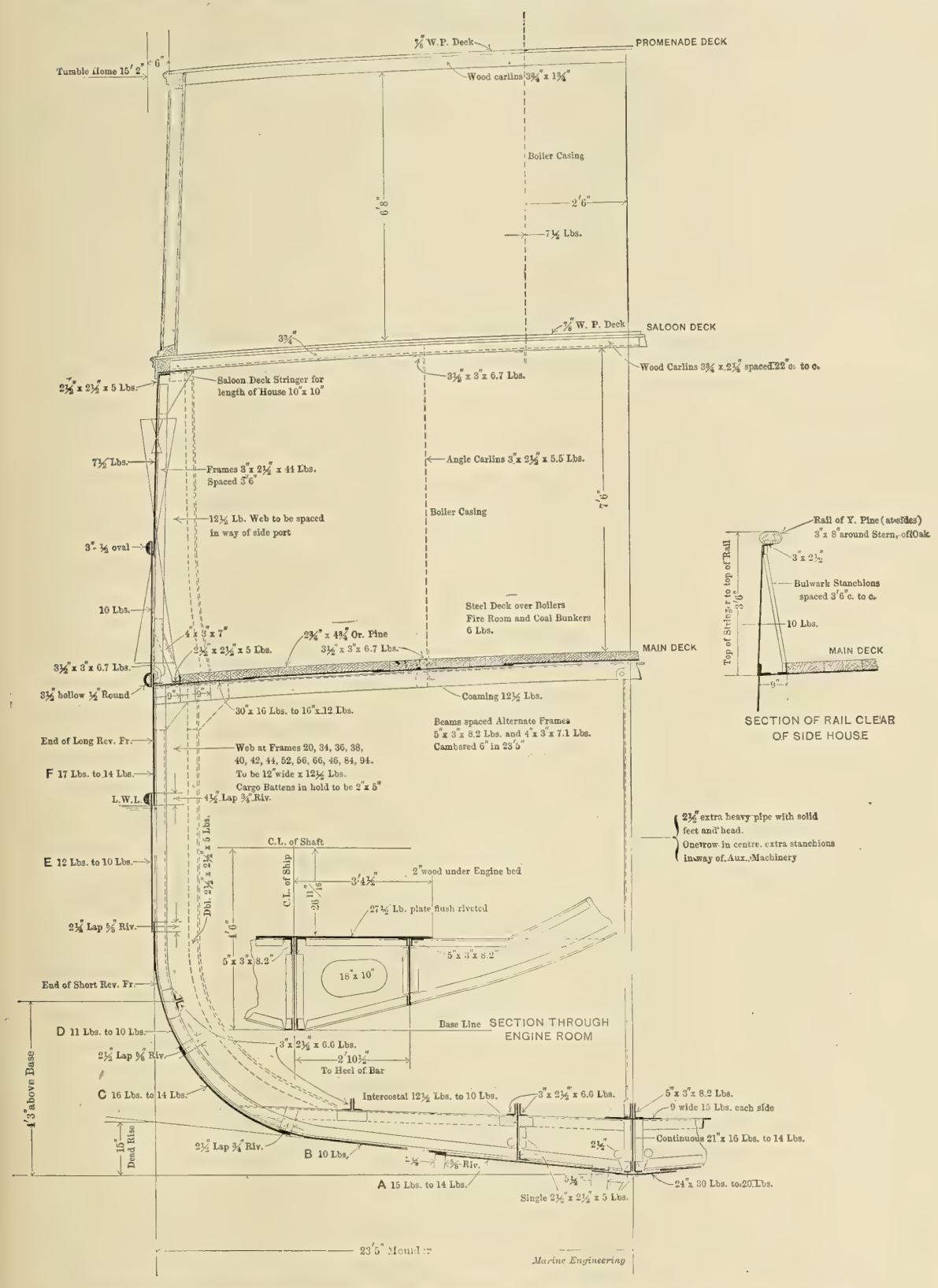


ELEVATION AND DECK PLANS OF THE STEAMBOATS PENN AND LORD BALTIMORE, RUNNING ON THE INLAND ROUTE BETWEEN PHILADELPHIA AND BALTIMORE.

the vessel at a speed of 19 miles an hour. The engine has cylinders of the following diameters: High-pressure, 21 inches; intermediate, 32 inches; two low-pressures, 35 inches each; the common stroke is 24 inches. One piston valve, 12 1-8 inches diameter is fitted on the high-pressure cylinder; two piston rods, each of 12 1-2 inches diameter are fitted on the intermediate, and a balanced slide valve on the low-pressure. The cylinders are mounted on the iron inverted Y box section framing at the back, and steel stanchions on the forward side. The engines are designed for fast running with as little vibration as possible, owing to the light construction of the hull. The arrangement of the cranks is, high-pressure opposite forward low-pressure, and the intermediate opposite the after low-pressure, with both pairs of cranks at right angles.

All pumps are independent of the main engines, as well as the condenser, which contains 3,000 square feet of cooling surface. The air pump is of the twin cylinder, vertical type, made by Davidson, who is the maker of the vertical feed pump. Blake tank, bilge, and sanitary pumps are installed. The crank shaft is a solid forging 9 1-4 inches diameter, while the line shaft is reduced to 9 1-8 inches and the propeller shaft increased to 9 1-2 inches. There are ten collars fitted on the thrust shaft, which is 9 1-4 inches diameter, the collars being 16 1-4 inches. The propeller has four blades, manganese bronze, is true-screw, 8 feet in diameter, with developed area of 21 square feet.

Steam is supplied by four Almy water tube boilers, placed in two stoke holds, each set of boilers leading to a separate funnel. The working steam pressure is 200 pounds, the grate surface 199.32 square feet, and the heating surface 6,879.2 square feet. For increasing combustion Bloomsburg steam jets are placed in the stacks.


PROMENADE DECK
SALOON DECK
MAIN DECK
Boiler Casing
Steel Deck over Boilers Fire Room and Coal Bunkers 6 Lbs.
Coaming 12½ Lbs.
Beams spaced Alternate Frames 5"x 3"x 8.2 Lbs. and 4"x 3"x 7.1 Lbs. Cambered 6" in 23'5"
Web at Frames 20, 34, 36, 38, 40, 42, 44, 52, 56, 66, 46, 84, 94. To be 12"wide x 12½ Lbs.
Cargo Battens in hold to be 2"x 5"
Saloon Deck Stringer for length of House 10"x 10"
Frames 3"x 2½" x 44 Lbs. Spaced 3'6"
12½ Lb. Web to be spaced in way of side port
Angle Carlins 3"x 2½" x 5.5 Lbs.
Wood Carlins 3¾ x 2¼" spaced 22" c. to c.
Wood carlins 3¾" x 1¾"
Tumble Home 15' 2"
SECTION THROUGH ENGINE ROOM
SECTION OF RAIL CLEAR OF SIDE HOUSE
Rail of Y. Pine (at sides) 3"x 8"around Stern, of Oak
Bulwark Stanchions spaced 3'6"c. to c.
2½" extra heavy pipe with solid feet and head. One row in centre, extra stanchions in way of Aux. Machinery
Intercostal 12½ Lbs. to 10 Lbs.
Continuous 21"x 16 Lbs. to 14 Lbs.
24"x 30 Lbs. to 20 Lbs.
Single 2½"x 2½" x 5 Lbs.
2"wood under Engine bed
27½ Lb. plate flush riveted
18"x 10"
To Heel of Bar
Base Line
Dead Rise
23'5" Moulded
Marine Engineering

MIDSHIP SECTION OF STEAMBOATS PENN AND LORD BALTIMORE, BUILT BY THE HARLAN & HOLLINGSWORTH COMPANY.

On a trial course 1 statute mile in length it was stated that the engines ran at 230 revolutions, developed 2,250 I. H. P. and drove the vessel at a speed of 25 statute miles.

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Notice to Advertisers.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

NOW that it is claimed by many steam engineers, that the highest point of economy with the present materials of construction has been reached with the steam engine through multiple expansion, the recent investigations concerning superheated steam and the results obtained of steam plants where superheat is used, are of special importance. Several years ago, when boiler pressures of from 20 to 50 pounds were ordinary, many types of superheater were patented and built in this country and abroad, and the records of tests show that in almost every case decided economy resulted. With the introduction of the compound and triple expansion engine, higher steam pressure, and earlier cut-offs, these superheaters were laid aside, doubtless because of the many difficulties met with by the engineers of those days in handling the increased temperature, and all of the attention was devoted to improving the economy through increasing the ratio of expansion. Several superheaters were installed on American vessels, some designed by the famous Isherwood, but all these have disappeared with the exception of the steam drum built around the smoke stack in several paddle wheel and small boats.

To-day there are running in Europe many large plants fitted with superheaters. Tests have been made which clearly demonstrate that the gain for the superheater is practical as well as theoretical. The American engineer is now following his foreign brother in adopting the superheater.

The advantages of superheat, as laid down by Rankin, are threefold, *viz.*: to raise the temperature at which the fluid receives heat and so increase its efficiency without producing a dangerous pressure; to diminish the density of the steam and so lessen the back pressure; finally, to prevent the condensation of the steam during its expansion, without the aid of a jacket. Instead of carrying a high pressure with saturated steam, the same amount of heat may be carried to the engine, and more efficiently at a lower pressure, with steam superheated. The advantage of a lower pressure and resulting lessened weights of both engine and boiler are apparent to all. The other actual gain in superheating steam results from decidedly reducing the loss by cylinder condensation. With saturated steam no transfer of heat, however small, can take place from the steam to the cylinder without the condensation of some steam and the depositing of it on the wall of the cylinder. Also the wet cylinder wall forms a good conducting medium for the radiation of latent heat from the saturated steam, causing increased condensation. Upon exhaust this steam is re-evaporated at the lower exhaust pressure by the heat in the walls of the cylinder. With superheat, part of the heat may be transferred to the walls without causing condensation, and being comparatively non-conducting, if dry at release, will receive very little heat from the cylinder walls; thus, it may be assumed that a higher mean temperature is secured to the cylinder walls. Experiments have fully demonstrated this decreased condensation with superheat. Therefore, that amount of heat radiated to the cylinder walls should be added to the steam before it enters the engine, in order to prevent cylinder condensation. Assuming this loss to be 20 per cent. of the latent heat, Regnault determines 520 degrees to be roughly the proper amount of superheat for ordinary pressures.

On the pages of this magazine will be found a description of a superheater which, in another form, has been installed for several years on

board ship, and in the present form has given conclusive proof of the great advantage to be derived from superheated steam. Two types of superheaters are built. First, that in which a separate fire is used, giving independent control of the degree of superheat; second, that in which the fire under the boiler is used for supplying the heat. This last may be subdivided again into one class where no regulation of the heat is possible, and a second class where regulation of the heat is independent of the fire under the boiler. It is to this last class that the superheater here illustrated belongs.

On board ship, where the coal economy is of prime importance, and every pound saved means so much more cargo space available, the steam superheater should find its place. Naturally the engineer is loath to see another auxiliary installed which will not only take more labor to look after but will involve another uncertain element in the steam line, subject to breakdown. However, with superheaters given ordinary care and attention, no trouble whatever has been experienced, and the amount of repairs has been practically *nil*. The economy of the steam turbine is most decidedly improved with superheated steam, even to a larger extent than with reciprocating machinery.

Believing this matter to be of great importance to the marine engineer, we commend this subject to our readers and will be pleased to receive their communications and data relating thereto.

AFTER many conflicting reports the directors of the Cunard Company have determined to fit their two new transatlantic express steamers with steam turbines. This decision has been reached after extensive investigation by a commission made up of the most prominent engineers and naval architects in the country. Comparative tests were conducted on two ships of the New Haven-Dieppe route, the ships being practically the same, only that one was fitted with reciprocating engines and the other with turbines. The commission has also exhaustively investigated different types of steam turbines and steam turbines plants on shore. The full report has not yet been made public, but it is understood that the power of the ships is to be divided on four shafts, the two outboard ones being fitted with high-pressure turbines, and the inside pair with low-pressure machines and also with the reversing turbines. Each shaft will have one propeller, as results, both in England and in France, have demonstrated that the efficiency is greater with one propeller of fine pitch running at a slip of not over 25 per cent. than when more than one are used on the same shaft. As a result of extensive model experiments it is understood that with a length of 760 feet, a beam of about 88 feet will be required to carry the enormous weight of machinery, and for driving the ships at 25 knots, the estimated indicated horse power will be not less than 70,000. While it is proposed to run the ships at an average speed of 24.5 knots for the entire voyage, the designs call for an extra half knot to allow for making up time due to delays of any cause.

This decision, arrived at after such extensive experiments and investigations is, indeed, an important one in marine engineering. The claims of the turbine builders for great reduction in weight and increased economy have, it is understood, not been substantiated by the commission's investigations, as it is stated that the saving in weight over reciprocating engines will be but 3 per cent., and the economy demonstrated on the channel steamer tests is only about 2 per cent., which is, indeed, disappointing. Results of steam turbine plants on shore, which have been in operation for a number of years, show much better economy than this. At present the vessels equipped with steam turbines include those running on routes across the English and Irish channels and a few yachts. Many ships under construction are to be fitted with turbines to ply along the British coast, in the Australian and New Zealand trade and on the Great Lakes, but the largest order was for the two Allan liners of 10,000 tons and 17 knots speed. With these vessels completed, abundant data will be attainable for a definite opinion as to the exact merits of the marine steam turbine.

WE have for some time realized that there has been a demand by shipbuilders and owners for a responsible agency where they might learn of experienced and competent men to fill vacancies from head of departments down to engineer or machinist. Therefore, we have undertaken, as elsewhere stated on these pages, such an exchange for the purpose of looking up the records of all men who apply and recommending only those who, in our opinion, can fill the requirements of the vacant position.

Launch of the United States Battleship Virginia.

BY H. H. BYRNE.

Another battleship has been added to our Navy. Amidst the usual ceremonies attending the launching of a war vessel, the *Virginia* was, on April 5, successfully launched at the Newport News Shipbuilding and Dry Dock Company's yard, Newport News, Va.

The general dimensions of the *Virginia* are:

Length on water line	435 ft. 0 in.
Breadth	76 " 2½ "
Draft, mean, at trial displacement,	23 " 9 "
Displacement on trial	14,948 tons.

As recent as 1898, when our navy had but four battleships, *viz.*, the *Oregon, Iowa, Indiana* and *Massachusetts,* the line of demarcation between them and the cruisers of their time was very sharply drawn. A comparison of the *Brooklyn* and *Oregon* will show how evident this is; the former is a cruiser of 9,215 tons, or 1,027 tons lighter than the battleship; has a greater horse power by 7,658 than the *Oregon,* and likewise carries more but smaller guns, 20 in all, or four more than is carried by the battleship. Now note the slight difference between the two new vessels, the battleship *Virginia* and the cruiser *West Virginia.* The former's displacement is about 15,000 and the latter's 13,268 tons. The difference in horse power between the *Virginia* and *West Virginia* is 4,000; while that between the smaller ships, the *Oregon* and *Brooklyn,* is 7,658. The *Virginia* and *West Virginia* have twenty-four and twenty-two guns respectively in their main batteries, the battleship, be it noted, having the advantage by two guns. Now with the *Oregon* and *Brooklyn* it is twenty guns to sixteen guns (main batteries), which is in favor of the cruiser. And in various other ways these former differences have been narrowed, overcome or reversed, until now a battleship is an excellent cruiser and a modern cruiser well compares with a battleship and would be more than a match for one of the *Oregon* type.

The *Virginia* is one of the three battleships provided for by Congress in 1899, which, with the two voted for in the session of 1900, are to compose a fleet known as the coast line battleships. These last two, the *Louisiana* and *Connecticut,* it will be remembered, are being constructed competitively, one by the Government at the New York navy yard and the other by a private firm, which, as it happens, is the same company that built the cruiser *West Virginia,* launched last April.

The *Virginia* will carry four 12-inch guns, mounted in pairs within turrets in their usual position, one forward and the other aft. Of the eight 8-inch guns four will be superposed in turrets on the turrets for the 12-inch guns; the other four will be housed in two separate turrets on either side of the vessel slightly forward of amidship. The 12-inch turret guns and likewise those superposed will have a sweep of three-quarters of a circle, those amidship will have a radius of one-half circle, thus enabling them to fire directly ahead or astern. The smallest gun of her main battery will be twelve 6-inch, equally divided on the vessel's broadsides; two being forward and four aft of the amidship turrets. These guns will be capable of firing at an object within an arc of 121 degrees.

The secondary battery will consist of twelve 3-inch rapid fire guns; twelve 3-pounder semi-automatic; eight 1-pounder heavy automatic; two .30-caliber machine guns, and six .30-calibre Colt automatic guns, all mounted in commanding positions and having large areas of fire, and two 3-inch field guns. The *Virginia* will also be fitted with submerged torpedo tubes.

The magazines have been exceptionally well fitted and provide room enough to stow away sixty rounds for each of the four largest guns; 125 rounds for every 8-inch; 200 rounds for every 6-inch and 300 rounds for each of the 3-inch guns and an almost unlimited supply of shell for the smaller guns.

The *Virginia* has a belt of armor 8 feet in width amidships that is 11 inches thick at the top and 8 inches at the bottom, this belt gradually tapers until it is 4 inches thick at both ends of the vessel. Extending from the top of this belt to the upper deck there is another belt of 6 inches thickness that extends from the forward to the after turret. Within this wall or casemate the broadsides or six-inches guns will be mounted, each one separated from the others by a steel splinter bulkhead. That part of the main turrets on the outside of the casemate will be protected by barbettes 10 inches thick, which will likewise shield the portion of the turret not in view, but the armor in this case will taper to 7 1-2 inches. The large turret walls are 12 inches in thickness, while the turrets for the 8-inch guns are to be protected by 6-inch armor, and have barbette protection similar to the other turrets. The conning tower and its shield will be 9 inches in thickness and an armored casing 5 inches thick will be large enough to protect all the speaking tubes, signalling wires, etc. The after conning tower is protected with 5-inch armor. To reduce to a minimum the effect that any shell would have if it did penetrate the armor and at the same time to doubly insure the ship's boilers and engines, there is a protective deck of nickel-steel 1 1-2 inches thick on the flat and 3 inches on the slopes. Just above this deck and for the entire length of the ship on both sides there will be a cofferdam belt three feet thick and packed eight pounds to the cubic foot.

The machinery will consist of two sets of four-cylinder triple-expansion engines, which are to develop 19,000 indicated horse power to drive the ship at 18 knots on trial. The engines have cylinders 35, 57, 66, and 66 inches diameter, by 48 inches stroke. Twenty-four water tube boilers of the Niclausse type will furnish the steam. The total grate surface will be approximately 1,280 square feet, and the total heating surface, 57,534 square feet. The normal coal bunker capacity is 900 tons, giving a steam radius at ten knots of about 3,500 nautical miles. The total bunker capacity, including reserve bunkers, is 1,700 tons.

When ready for sea the *Virginia* will carry 44 officers and a crew of 768 men, including marines, and if need be she can be used as a flagship, for she has ample accommodations for an Admiral and his staff.

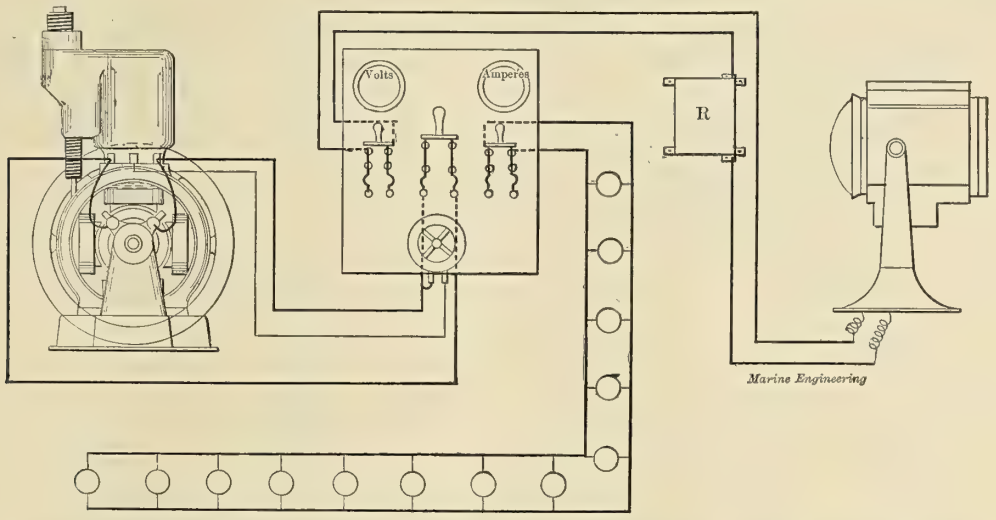
Like in all ships built nowadays electricity is one of her most important factors. The ammunition hoists, turret, operating machinery, aside of the ship's locomotion, capstan and steering gear, are to be operated by electricity. For these purposes she is to have eight engines and dynamos.

ENGINEERING SPECIALTIES.

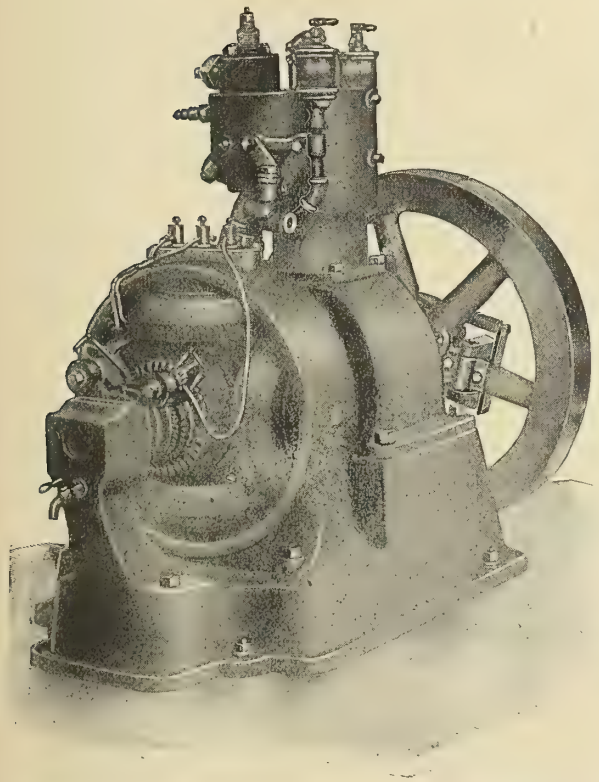
Small Gasoline Engine-Driven Generator.

For those owners who do not care to use a storage battery in their electric lighting outfit, there are two alternate equipments; the first for larger boats of any description (power or sail) consists of a generator direct connected to a small gas engine; the second, the smaller class of motor boats is simply a generator driven by belt from the flywheel of the propelling engine and properly connected up.

A type of the first outfit is illustrated on this page and consists of a generator direct connected to a 2 1-2 H. P. gasoline 4-cycle single-cylinder engine. The speed of the dynamo is 750 revolutions per minute. The armature is compound wound and mounted on a sleeve which slips over the crank shaft and is held securely in place by means of a long key. The governor is contained in the flywheel and gives close regulation varying only 2 per cent. from no load to full load. The floor space occupied is 20 to 34 inches, the height over all is 30 inches and the weight complete is but 475 pounds. The switchboard has mounted upon it the field regulator rheostat, a main switch and two smaller switches, one on each side, one controlling a circuit for the incandescent lamps and the other the searchlight circuit. On the upper part of the board are placed an ammeter and voltmeter. The connections are not shown on the back of the board for simplicity's sake, but the circuit may be easily traced out from the plan. At *R* is the searchlight resistance, which is connected in series with the searchlight and to be placed anywhere out of the way, where the heat produced will not cause injury. Of course, if the searchlight is not desired more incandescent lights may be installed and the number of circuits increased. In this plan simplicity has been aimed at and as few switches, cut-offs, etc., as possible have been used. This generating set and searchlight are manufactured by the Carlisle & Finch Co., 234 E. Clifton ave., Cincinnati, O.



WIRING PLAN OF CABIN- AND SEARCHLIGHTS, GENERATOR DIRECT CONNECTED TO 2 1-2-H. P. GASOLINE MOTOR.



GENERATOR DIRECT CONNECTED TO 2 1-2-H. P. GASOLINE ENGINE.

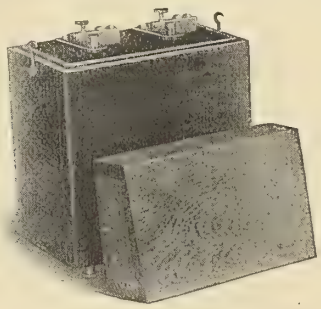
Induction Coil for Igniter.

That form of device for igniting the charge of gasoline and air in gas engines which is now generally considered the best, is the jump spark system. It is more economical in battery and it provides more rapid and complete combustion of the gases, owing to the greater heat produced at the spark points.

Its use eliminates all working parts within the cylinder, thus doing away with a constant source of annoyance. It will ignite gases having greater variation in quality than will any other form of ignition, thereby

providing a greater range of usefulness for the engine. It is noiseless, has no rods, hammers, working joints, etc., to wear out, and in addition can be applied at smaller cost, except, perhaps, on the small sizes of cheap stationary engines.

The Mueller coil here illustrated can be relied upon to ignite the charges even where the engine works with highest compression. A poor coil is liable to miss sparking under these conditions, for as compression increases so does the resistance to the passage of the electrical current across the spark points. These coils



DOUBLE DASH INDUCTION COIL FOR IGNITING OUTFIT.

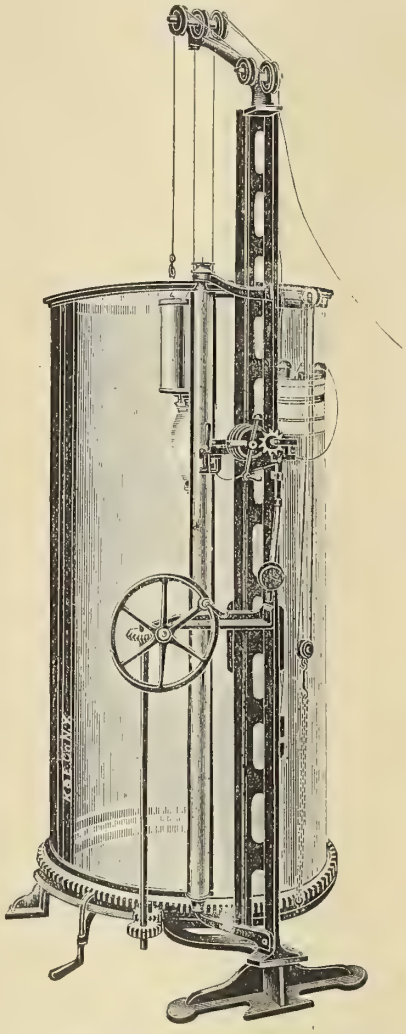
are the result of many years of practical experience in such class of work, and are of the very best type; insulation is of the heaviest. A distinctive feature of the Mueller coils is a safety gap, so set and gauged that should the plug wires ever become detached through accident or otherwise the coil cannot readily be damaged, as the spark will jump from one secondary terminal to the safety plug. Thus the possibility of the coil being short circuited is practically nil, and renders the motor more reliable when in the hands of an inexperienced operator. When the spark points are used up, a new vibrator spring with an iridium-platinum point may be furnished, for these parts are interchangeable.

The Induction Coil Company, 9 Miller Building, Milwaukee, Wis., make these coils in a variety of forms for different services.

Cylindrical Electrical Printing Frame.

Sunlight is such an uncertain quantity to depend upon where many and large blue prints are required that most manufacturing concerns now are using the printing frames adapted to print by electric light. The one herewith illustrated is made by the Keuffel & Esser Company, 127 Fulton street, New York, N. Y. It is formed of a vertical cylinder and consists of two sections of curved glass mounted in a metal casing and together forming a cylinder which rotates on a circular base. It requires a floor space of about 36 by 42 inches. The lamp is suspended in the axial line of the cylinder, where it travels by clockwork with electric motive force.

Tracing and paper are placed on the outer surface of the glass cylinder, where they are held by a canvas curtain mounted on a vertical roller attached to the upright which carries also the lamp and the mechanism for moving it. This curtain is wound on the cylinder by rotating the cylinder on its base, which is done by a conveniently placed handwheel. It is held tense by the roller spring and a foot brake on the base plate, which arrests the cylinder. The rotating of the cylinder therefore automatically winds the curtain on to it and holds the tracings and paper in very good contact. The feeding in of the tracing and paper is easily and quickly accomplished, and there is no tilting of the glass cylinder. The unwinding of the curtain is done by means of the handwheel, assisted by the spring acting on the curtain roller.

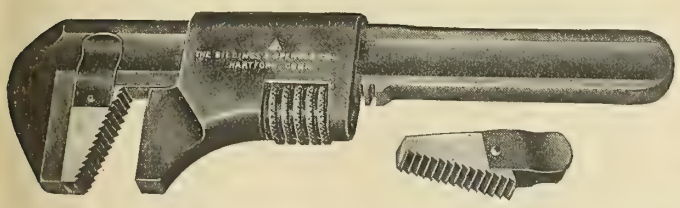


CYLINDRICAL ELECTRIC PRINTING FRAME.

The lamp is of a special pattern to give perfect diffusion and distribution of light. It is moved by clockwork and can be set to any required speed, to any distance of travel, and to start from and stop at any point. The current is cut off automatically at the end of the travel of the lamp. Either direct or alternating current lamps at 110 or 220 volts are furnished with frame. This is an economical apparatus, as it requires only one lamp even for the largest size tracings. The tracings may be inserted and removed quickly and conveniently, as the position of the cylinder does not have to be changed for loading or unloading.

Patent=Adjustable Pocket Wrench.

A combination adjustable wrench with a pipe wrench attachment is, indeed, a handy thing for any engineer or motor launch operator. Such a wrench, made by the Billings & Spencer Company, Hartford, Conn., is here illustrated. The wrench can stand the hardest kind of usage, and is for all purposes for which the monkey wrench is used. It is made throughout of drop forging from steel bar and in two styles, case hardened finish or nickel plated.



POCKET WRENCH WITH PIPE WRENCH ADJUSTMENT.

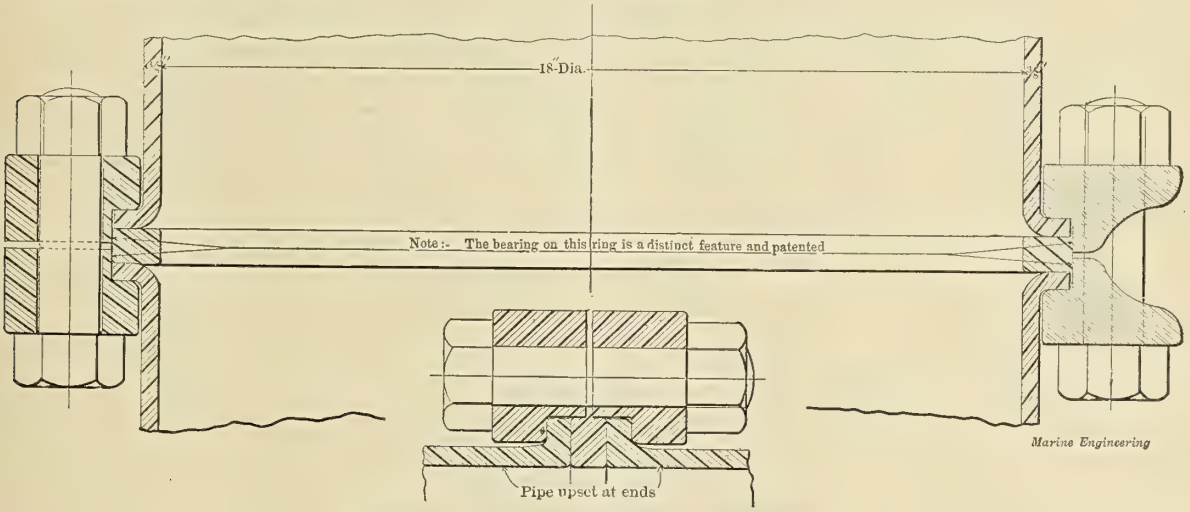
The pipe wrench adjustment consists of a serrated tool-steel jaw with a tempered steel spring, which serves to hold the jaw in place on the wrench. The advantage of this adjustment is that it enables one to instantly convert the adjustable wrench into a pipe wrench, which can be used on pipe up to and including ¾ inch in diameter. The wrenches are made in sizes up to 18 inches, while that shown in the engraving, fitted with the pipe-wrench adjustment, is 8 inches.

hold the pipe flanges in contact with the joint ring. The latter provides a good surface for the flanged ends of the pipe, and also serves on its outer rim as a strut to resist the distortion of the loose flanges due to the tension of the bolts. This fitting of the loose flanges over the joint ring constitutes a special feature of the patent. By this simple device the effective section of the loose flanges becomes equivalent to the combined areas of the flanges and ring.

An internal pressure tending to distend the ring still further adds to its strength against collapse, and sets up a moment which offsets the moment of the bolts tending to distort the loose flanges. Thus, also, the internal pressure automatically increases the tension of the bolts and tightens the joint thereby.

This type of joint allows the loose flanges to be smaller in diameter than any type of fixed flange, as the bolt heads and nuts may be brought close in to the pipe, hence a neater and lighter design is possible, especially for large sizes. For work in close quarters and field work generally this joint is especially suitable. The flanges can be revolved into any position required. The holes are drilled in the shop, and the work is therefore accurate and cheap. Moreover, the joint ring is not put in place till ready to couple up, leaving a still better chance to fit pipes in place or take them down.

The loose flanges may be made of any suitable material, cast or wrought, but the latter is preferable in order to eliminate risk of breakage. The section of the flange will be modified to suit material, as shown in illustration.



FORMS OF PATENT LOOSE FLANGE PIPE CONNECTION.

Patent Loose=Flange Pipe Connection.

One of the greatest problems of engineers ashore and afloat is to get a pipe connection that will be absolutely tight, and yet not involve the use of awkward and expensive flanges. A careful study of the loose flange connection illustrated herewith will show how this problem has been solved by Mr. L. D. Lovekin, chief engineer of the New York Shipbuilding Company.

Special attention is called to the function of the joint ring against which the pipe-ends bear. The ends of the pipes themselves are flanged and form the joint surface. The loose flanges serve simply as a powerful clamp to

The cheapest and best method of turning over the flange in the pipe is by the use of the Lovekin expanding and flanging machine. With this machine, pipes of any size, from 2 inches to 24 inches, may be flanged cold, and the work rolled over so perfectly that no machining is necessary. This applies both to copper and wrought steel or iron piping. In the case of copper, of course, it does away entirely with brazed joints, and this will appeal strongly to all engineers, who know the danger of brazed connections. For extremely high pressures in steel pipe, type of joint is shown where the pipe is upset and flanged over while hot.

Screw Propeller Planing Machine.

The machine herewith illustrated and described was recently built for the experimental tank at the Washington navy yard by the Builders Iron Foundry, Providence, R. I., for planing the blades of the screw propellers. By the use of this machine, it is intended to cut a great number of model propellers of different forms for an extensive series of investigations in connection with the ship models tested in the experimental tank. Previous experiments with propellers have been limited to those conducted with propellers mounted independently of the vessel in either moving or still water. The following description of the planing machine is taken from *Machinery*.

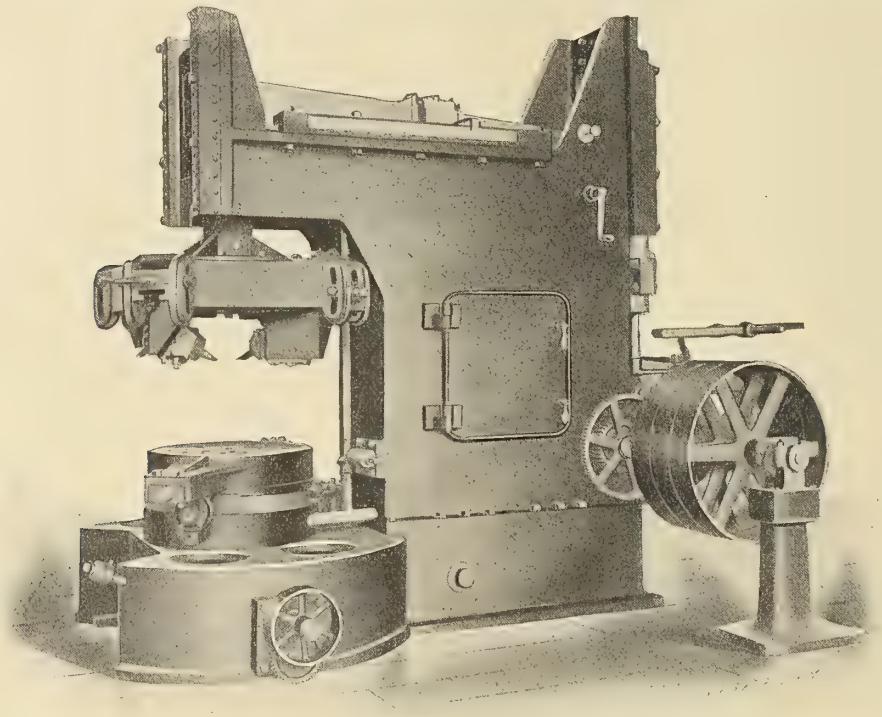


FIG. 1. PROPELLER PLANER FOR MACHINING THE BLADES OF PROPELLERS FOR EXPERIMENTAL PURPOSES.

The general features of design of the planer were outlined by the Navy Department, and were original with Naval Constructor D. W. Taylor. The details of construction, however, were left with the builders, and were worked out by Mr. F. N. Connet, mechanical engineer of the Builders Iron Foundry. The planer operates on rough bronze propeller castings of two, three or four blades, ranging from five inches to 24 inches in diameter, and will finish both the fronts and backs of the blades. The cutting is accomplished by diamond-point or round-nose tools, the tools and work being given such relative motion as to cause the surface of the blade to have the required pitch and form. The propeller is mounted, with its axis vertical, upon a horizontal table, which has a reciprocating rotary motion about its vertical axis. The cutting tools are carried by a cutter head, which has a reciprocating motion in a vertical direction, timed to correspond with the motion of the table. Provision is made for varying the extent of the travel of the cutter head, relative to the motion of the table, by this means varying the pitch of the surface being planed. The machine is driven by a shifting-belt mechanism, similar to a planer of the usual type, the shifting mechanism, in this case, being controlled by dogs clamped in a T-slot on the periphery of the table. Both the cutter head and the table are operated by the same shifting belt, and the feed for the tools is operated by a planer feed mechanism with friction clutch.

In Fig. 1 is a side view of the machine, and in Fig. 2 is a side elevation indicating many details of construction. The belt pulleys are three in number, 30 inches diameter and 5-inch face, the two outside pulleys being loose, and the middle one *A*, in Fig. 3, is tight on its shaft and transmits motion through the bevel gears, *BB*, to the vertical driving shaft, *C*. This shaft consequently changes its direction of rotation with each reversal of pulley *A*, and the reciprocating motions of both cutter head and table are derived from it.

At the lower end of the driving shaft are bevel gears *L* and *M*, Fig. 3, loose on the shaft, but either of which may be set in motion by a clutch which is splined to the shaft. These gears mesh with a third bevel gear, *N*, Fig. 2, and transmit motion through the shaft, *O*, to a worm, *P*, and wormwheel, which drive the table, and give it its reciprocating motion. The object of the two bevel gears and clutch on the driving shaft is to reverse the direction of rotation of the table, relative to the motion of the driving shaft, so that either right- or left-hand propellers may be planed.

At the upper end of the driving shaft is a double-threaded screw, 3 1-2 inches diameter, 3-4 inch lead, which runs in an adjustable bronze nut, forming part of the crosshead, *E*. This crosshead is connected with

the walking beam, *F*, Fig. 2, by a sliding and pivoted joint, and the walking beam, at its opposite end, is similarly connected with another crosshead carrying the tool head *I*. It is evident that in the production of the surfaces of a propeller blade, the motions of the blade and tool are entirely analogous to the motions of the corresponding parts when thread cutting in a lathe. That is, for a propeller of uniform pitch, the propeller must rotate uniformly, and the tool must advance uniformly just as the work turns uniformly, and the carriage and tool post advance uniformly in the case of the engine lathe. In the propeller planer the driving shaft has a uniform rotary reciprocating motion, received from the driving belt, as we have already seen, and this is reproduced in the motion of the table through the bevel-and-worm-gear connections. The design of the travel of crosshead *E* is always relatively the same as the travel of the table, it is evident that adjustment of position of the fulcrum of the walking beam enables propellers of various pitches to be planed. To facilitate setting the machine, the frame adjacent to the walking beam is graduated, and indicates where the fulcrum must be set to correctly plane a propeller of given pitch. The maximum movement of crosshead *E* is 8 inches, and the movement of the cutter head can be varied from 1 inch to 12 inches.

The work table of the machine is 27 inches in diameter, and is arranged so that it can be raised or lowered either by hand or by power, to bring the work into position for machining. The gearing for this purpose is shown at *R*, in Fig. 2. Provision is also made for the automatic lifting of the table while the

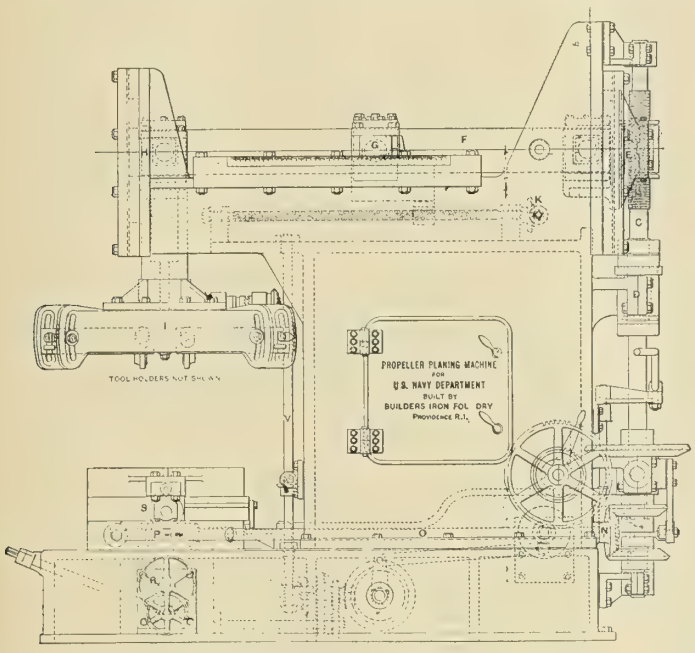


FIG. 2. SIDE ELEVATION.

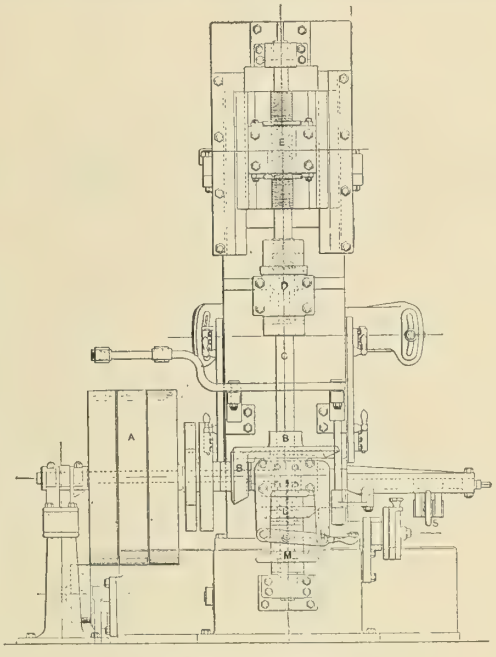


FIG. 3. END ELEVATION.

the walking beam, also, is such as to give a uniform advance and return to the cutter head, this being accomplished by the crosshead at each end, guided in a straight, vertical line, in connection with the walking beam, which is so arranged that each end slides in a block pivoted to the crosshead at that end. The arrangement maintains a constant ratio between the lengths of the two arms of the walking beam, whatever the angle of inclination, and the motion of the cutter head thus accurately reproduces the motion transmitted by the screw at the upper end of the driving shaft, *C*.

The walking beam is a steel forging of rectangular cross section and has an adjustable fulcrum consisting of a trunnion block, which can be clamped to the walking beam at any desired position along its length. This block has two trunnions supported in boxes carried by a casting which can be adjusted to any desired position by means of a crank, *K*, Fig. 2, a pair of bevel gears, and a screw. The adjustment of the position of the fulcrum varies the distance traveled by the cutter head, *I*, for each inch of travel of crosshead, *E*; and as machine is in operation, through the use of two cam surfaces, bolted to the base of the machine, or diametrically opposite sides of the table. By raising the table during the downward, or cutting stroke of the tool, the effect is the same as though the cutting speed of the tool were changed, thus allowing the propeller to rotate a greater or less amount, according to the shape of the cam, for every inch of travel of the tool, and producing a propeller of variable pitch. By laying out suitable cams any desired variation in pitch can thus be obtained. There are two horizontal arms, extending radially outward from the table, as shown clearly in the half-tone illustrations, each of which carries a sliding block supporting a steel roll. These rolls ride up and down on the cam surfaces as the table reciprocates, alternately raising and lowering the table. Provision is made for feeding the rolls out or in along the radial arms, their motion keeping pace with the out or in feed of the cutting tools; and by making the cam with a surface of changing curvature, different pitches can be employed for the inner and outer ends of the propeller blades.

In Fig. 4 is a view of the under side of one of the cutter heads. This head has four radial slots or channels, in each of which are slides or ways that carry the tool heads. The cutter head is designed for planing either two- or four-bladed propellers, and there is a second head having three radial slots spaced 60 degrees apart, for planing three-bladed propellers. The specifications for the machine called for the feeding of the tools in a radial direction in a horizontal plane, and also the ways on which the tool heads traveled should be capable of being swiveled up to 10 degrees in either direction with the horizontal, the object being to provide for propellers having rake to the blades. The slides are pivoted at their inner ends, and are clamped in position by two bolts at their outer ends. Each tool head carries a tool post attached to a swiveling apron, similar to the tool heads of planers and shapers, and two sets are furnished, one right-hand and one left-hand, for cutting right- and left-hand screws, and

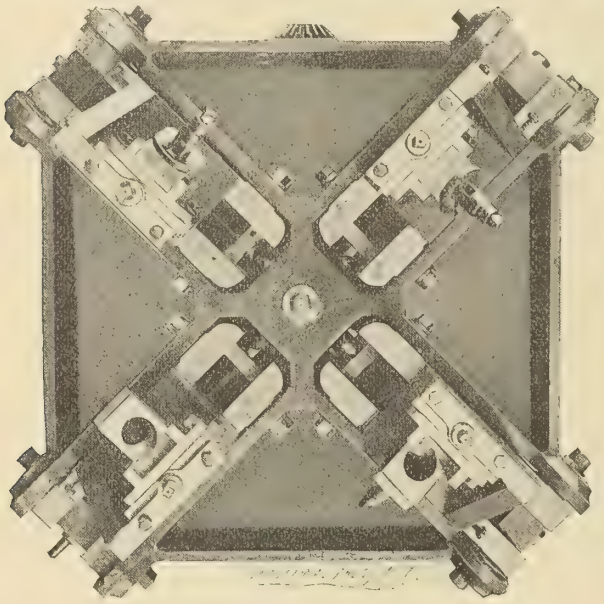


FIG. 4. VIEW OF CUTTER HEAD FROM UNDERNEATH.

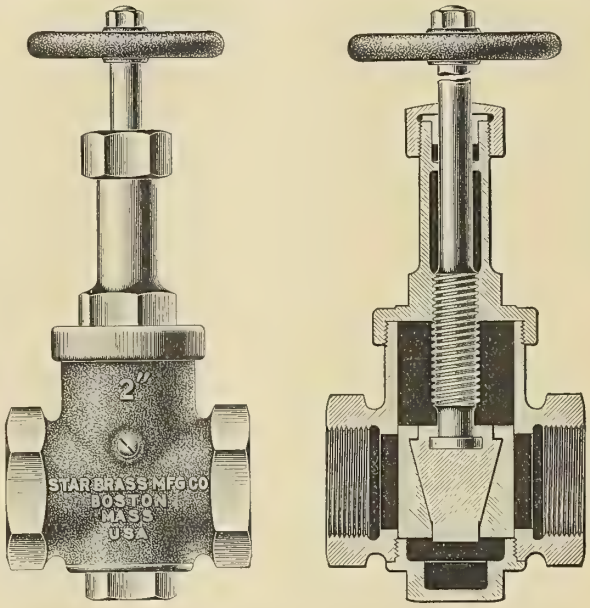
all of them have adjusting screws for vertical adjustment of the tools.

The feeds for the tool heads are derived from a central stud gearing with feed screws, which extend radially one for each slide. The feed screws have universal joints at their inner ends, to allow motion to be transmitted when the slides are tilted above or below the horizontal. The central feed stud derives its motion from the bevel gear seen on the outside of the cutter head at top of the engraving, Fig 4, and this gear in turn meshes with a gear on the splined feed shaft, *V*, in Fig. 2. At the lower part of Fig 2 the gearing connecting this feed shaft with the rachet wheel operated by the friction feed mechanism of the planer is shown by dotted lines. The cam rollers on the table arms also derive their feed motion from the same device.

The machine is back-geared, and is belted to a countershaft driven by an electric motor. It weighs about 10 tons, is 8 feet 10 inches high, 4 feet 10 inches wide, and 8 feet 3 inches long. It works to the entire satisfaction of the government officials and the builders.

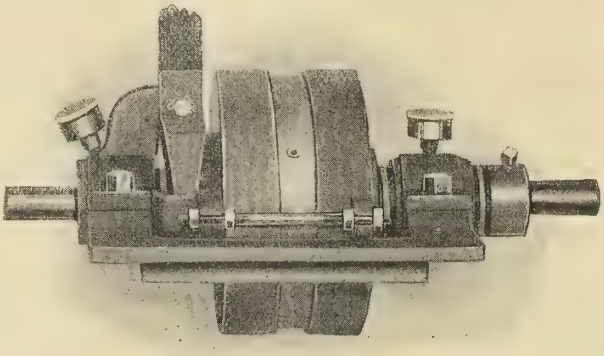
Improved Blow-off Valve

A valve which is guaranteed to close tight and always remain so, is not affected in any way by scale or dirt is made by the Star Brass Manufacturing Company, 114 East Dedham street, Boston, Mass. The valve will work equally well under high or low steam pressures. It is made entirely of composition. As shown in the cut, the operation of closing consists of the central wedge expanding a half piston which is very accurately



OUTSIDE AND SECTIONAL VIEWS OF IMPROVED EXPANDING WEDGE BLOW-OFF VALVE.

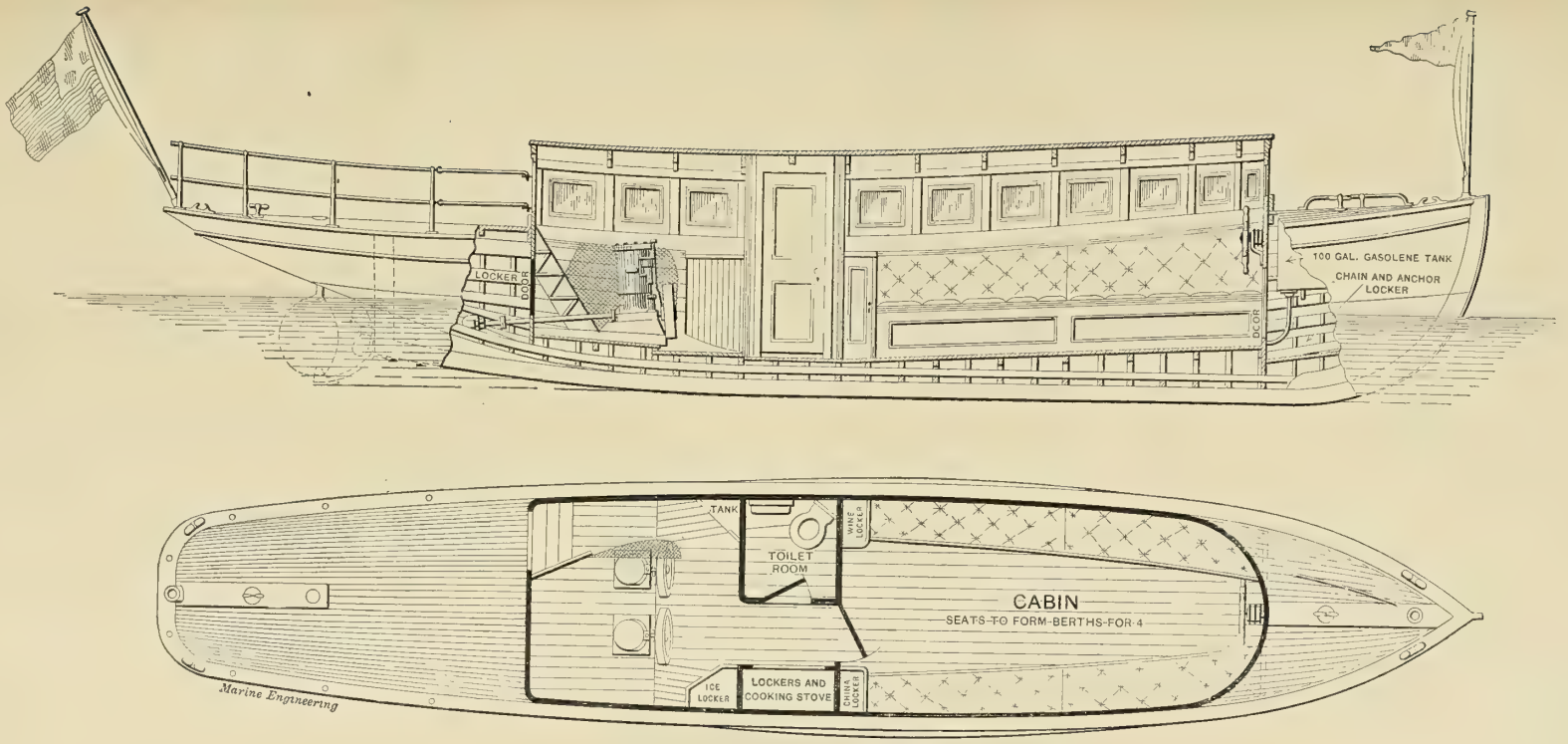
fitted to the cylindrical chamber in the valve body. When opening, the first movement of the valve spindle relieves the pressure between the wedge and the piston when further turning of the handle raises the piston until the full opening of the valve is reached.



A NEW FORM OF REVERSING CLUTCH.

Reversing Clutch for Marine Engines.

The difficulty of reversing the motion of a propeller driven by a gasoline engine has probably more than any other feature caused trouble. As the usual type of gasoline engine does not reverse, special gear has to be fitted for reversing the propeller, or changing the pitch of the blades, to secure a backward motion. The reversing clutch here illustrated is one for which a claim is made



TWIN SCREW MOTOR LAUNCH JOSEPHINE.

of very smooth running, the operator has perfect control of the propeller, and reversal of motion can be obtained without shock to the engine, gear or propeller.

The engine is, of course, run forward at all times, but when the vertical lever, shown broken off at the top of the left-hand side of cut, is set forward a frictional hood is forced upon the frictional cone at the centre. The hood is attached to the forward end of the shaft and the cone to the propeller end. For reversal, a second hood, driven by gearing, is forced upon the cone. These gears are always in mesh, but never in use except when the propeller is reversed. Also there is small liability to breakage, as connection is made entirely by friction.

The clutch is fitted with three sets of ball-thrust bearings, thereby reducing the friction to a minimum, and all parts are well fitted and easily accessible. The frame makes the propeller as rigid as it would be if solid from the engine out. The device may be connected with any marine engine, and takes up but very little space. It is made by the Holliday Manufacturing and Engineering Company, 160 Bunker street, Chicago, Ill.

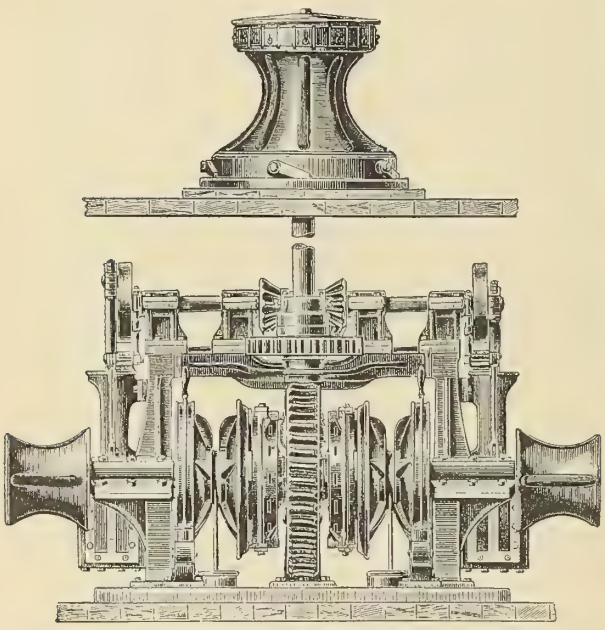
Twin Motor Launch Josephine.

One of the new small boats coming out this season is to be named the *Josephine,* and is built by E. C. Johnston and Company, Nyack, N. Y., formerly the Pinckney Company. The boat is to be 40 feet long, 8 feet beam, 2 feet 9 inches deep, and is for Commodore E. H. Luebbers, Jr., of the United States Life Saving Corps. The launch is equipped with two motors six horse power each. The reversing and operating rods are placed near the steering wheel at the forward end so that the engine is controlled by the wheelsman. The boat is furnished throughout in a substantial manner and handsomely finished, being fitted more for comfort than speed, but ten miles an hour are to be attained. She is lighted throughout by electricity.

The *Josephine* is to be added to the flotilla of the Hudson River Yacht Club, of which the owner is a member.

Steam Capstan Windlasses.

The Manton windlass, now made by the Rusden Machine Company, of Warren, R. I., comprises many special distinctive features. From the illustration of the steam capstan windlass, given on this page, it will be seen that the machine is very compact and it is claimed takes only one-half of the floor space occupied by corresponding machines of other makes. The capstan can run independently of the windlass, being arranged to work by hand when without steam. The locking key is always inside, so in an emergency can



STEAM CAPSTAN WINDLASS.

be seen whether the windlass is locked without stopping to try. The thrust bearing of the worm has a firm foundation on the bedplate, thus preventing any liability of twist or breaking. A windlass may be driven either way without reversing engines and can also be rolled in or out by simply taking off the bitt caps without disturbing any other part of the machine. The deck pipes being set angling supply the chain easily and allow a better grip on the wildcat.

There are ten sizes of steam capstans made by this company for handling chains from 1 inch to 2 1-8 inches. The machines are simple and built in a thoroughly workmanlike manner, the working parts being made of very best material. The pump brake attachment is supplied when desired.

The Shipping Bill Passed.—On April 8 the House of Representatives passed the Philippine shipping bill, which provides that no merchandise for passengers, except supplies for the Army or Navy, shall be transported by sea, under penalty of forfeiture, between the United States and the Philippine Islands in any vessels except those of the United States The bill was amended to become operative July 1, 1906, otherwise it is similar to the Senate bill already passed.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, report under date of April 9, 1904, the following degree of completion of vessels building for the United States Navy:

			Degree of Completion, Per Cent.	
			Mar. 1.	Apr. 1.
BATTLESHIPS.				
Ohio	18 knots.	Union Iron Works	88	91
Virginia	19 "	Newport News Co.	55	56.8
Nebraska	19 "	Moran Brothers Co.	41.6	44.5
Georgia	19 "	Bath Iron Works	47.6	49.91
New Jersey	19 "	Fore River S. and E. Co	52.1	55.3
Rhode Island	19 "	Fore River S. and E. Co.	54	57
Connecticut	18 "	Navy Yard, New York, N. Y.	30.86	34.56
Louisiana	18 "	Newport News Co.	40.56	44.27
Vermont	18 "	Fore River S. and E. Co.	4.6	5.6
Kansas	18 "	New York Shipbuilding Co.	5.2	6.3
Minnesota	18 "	Newport News Co	18.29	21.65
Mississippi	17 "	Wm. Cramp and Sons	0	0.7
Idaho	17 "	Wm. Cramp and Sons	0	0.6
ARMORED CRUISERS.				
Pennsylvania	22 knots.	William Cramp and Sons	68.6	71.2
West Virginia	22 "	Newport News Co.	76.76	80.25
California	22 "	Union Iron Works	56.5	58
Colorado	22 "	William Cramp and Sons	73	77.5
Maryland	22 "	Newport News Co	71.22	75.88
South Dakota	22 "	Union Iron Works	52.5	54
Tennessee	22 "	William Cramp and Sons	19.5	23.4
Washington	22 "	New York S. B. Co.	17	20.9
PROTECTED CRUISERS.				
Denver	17 knots.	Neafie and Levy	98	99
Des Moines	16½ "	Fore River S. and E. Co.	99.5	100
Chattanooga	16½ "	Lewis Nixon	72.6	75.71
Galveston	16½ "	Wm. R. Trigg Co	73.5	75
St. Louis	22 "	Neafie and Levy Co.	38	40.9
Milwaukee	22 "	Union Iron Works	44.5	46
Charleston	22 "	Newport News Co.	64.5	67.2
GUNBOATS.				
Dubuque	12 knots.	Gas Engine and Power Co.	29.1	33.5
Paducah	12 "	Gas Engine and Power Co.	25.5	29.1
TRAINING SHIPS.				
Cumberland	Sails	Navy Yard, Boston	26	28.5
Intrepid	"	Navy Yard, Mare Island	9	12
TRAINING BRIG.				
Boxer	Sails	Navy Yard, Portsmouth	20	28
TORPEDO BOATS.				
Stringham	30 knots.	Harlan and Hollingsworth	93	93
Goldsborough	30 "	Wolff and Zwicker	99	99
Blakely	26 "	George Lawley and Son	99	99
Nicholson	26 "	Lewis Nixon	99	99
O'Brien	26 "	Lewis Nixon	98	98

Quarterly Shipbuilding Returns.—The Bureau of Navigation reports 177 sail and steam vessels of 55,066 gross tons built in the United States and officially numbered during the quarter ended March 31, 1904. During the corresponding quarter ended March 31, 1903, 187 sail and steam vessels of 58,588 gross tons were built in the United States and officially numbered. There is an increase in the sailing wood tonnage built on the Atlantic Coast during this quarter and slight increase in the steel tonnage of the Atlantic and a large falling off in the steel steam tonnage in the Pacific. The total tonnage built during the nine months concluded March 31, 1904, was 232,133 gross tons, and during the corresponding months of last year, 231,187 gross tons.

THE USE OF SUPERHEATED STEAM.—II.*

BY PROF. STORM BULL.

In the discussion which followed the reading of the paper on this topic, and in answer to the questions addressed the author, the following facts were brought out:

In answer to the question, why the radiation in the cylinders coated on the inside with moisture is greater than when there is no moisture on the inside, Professor Bull stated he had found by experiment that the heat lost by the steam in an ordinary engine using saturated steam is always increased very rapidly with the adherence of the moisture to the metal surface. If you can keep that surface dry there is a very rapid decrease of condensation. Suppose you use superheated steam, then first of all the steam has to lose a great amount of heat before it will condense, consequently for a long time no moisture will be found, and the rate of change will be greatly reduced. It is only where the moisture covers the walls that this rapid condensation takes place. These conclusions have, of course, only been reached by means of experiment.

With superheat it appears that there is less gained in economy by using high expansion in engines where there are more than two stages of expansion than with reciprocating engines.

European makers of the highest grade of engines using superheated steam have abandoned the Corliss valve and are now using poppet valves, except for high speed of revolutions, when piston valves are substituted. A greater economy is shown with superheat used with the turbine than with the compound engine. It is possible to use ordinary rubber gaskets, but they must be of the very best quality. As the temperature is increased two or three hundred degrees, allowances must be made in the design of the engine for nearly double the expansion, and therefore engines designed for saturated steam cannot run with a high degree of superheat without more or less changes.

In reply to a written communication from Mr. C. W. E. Clark, on the amount of superheat for steam and reciprocating engines, and the cost of repairs and upkeep, Professor Bull stated that, from his personal inspection, he found that most plants constructed in Germany during the last five years used superheat of at least 200 degrees Fahrenheit, and that with respect to lubrication and maintenance they have been very satisfactory. As to the type of superheater, the question seems yet to be an open one, although it looks as if in the last few years the wrought iron type has been the most popular. While with the independently fired superheater the control is much easier, yet the question of control is only a part of the general question for the cost of installation and the better utilization of hot gases under the boiler must be taken into consideration.

In reply to a communication by Mr. A. Sorge on the practical side of running with superheated steam, the speaker stated that while it would not pay to install a superheater next to a coal mine where the cost of fuel is very low, yet, just as in Europe, so in the United States there are many places where it will pay to use superheated steam and the most economical engines.

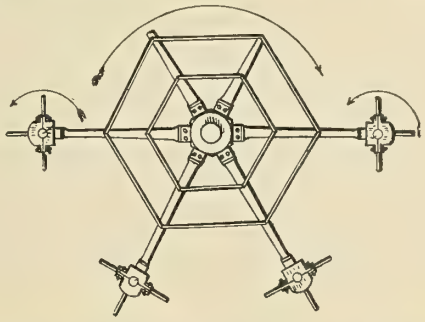
*Discussion on paper presented before the Western Society of Engineers, November, 1903.

SELECTED MARINE PATENTS.

753,217. MEANS FOR REMOVING SAND-BARS. EUGENE H. ALLMAN, MOBILE, ALA.

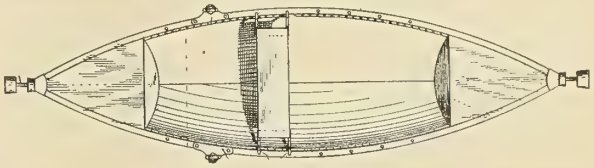
Claim.—1. An improved apparatus for the purpose specified, comprising a float, a framework applied thereto, a series of standards supported in said framework, and a series of plows secured to the lower ends of the standards which are adapted to project below the float. Six claims.

753,358. PADDLE-WHEEL. THOMAS J. CAMPBELL, Economy, Pa.



2. A paddle-wheel, comprising a shaft, hubs thereon spaced apart, radial spokes projecting from the hubs, braces connecting the spokes to the respective hubs, bearings in the spokes, and revoluble paddles, having shafts journaled in said bearings and disposed parallel with the shaft of the wheel, said revoluble paddles having radially-disposed blades, which converge to and are joined at their respective axes. Two claims.

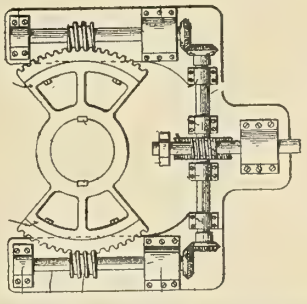
753,425. METAL BOAT. SYLVESTER D. NOEL, INDIANAPOLIS, IND.



Claim.—1. The combination with a boat having an angle-iron gunwale with a horizontal top member, said member having a plurality of equidistant holes, of removable seat and oar-lock attachments adapted to be supported from said horizontal member and fastenings therefor entering said holes. Three claims.

753,445. ARTIFICIAL HORIZON FOR USE OF MARINERS. JAMES M. STRATTON, BROOKLYN, N. Y. Two claims.

753,576. STEERING-GEAR. HERBERT W. HOOVER, NEWPORT NEWS, VA.



Claim.—1. The combination with the rudder-stock, the toothed gear secured thereto and composed of sections as described, the foundation or support and bearing-ring for said gear, shafts provided with worm-wheels, said worm-wheels engaging said toothed gear, gear-wheels on said shafts engaging similar wheels on a transverse shaft, a gear-wheel on the transverse shaft, and a shaft, provided with a worm-wheel engaging said last-mentioned gear-wheel; and means for driving said shaft. Two claims.

753,717. FISH-TAIL PROPELLER. ZDENKO von LIMBECK, VIENNA, AUSTRO-HUNGARY. Five claims.

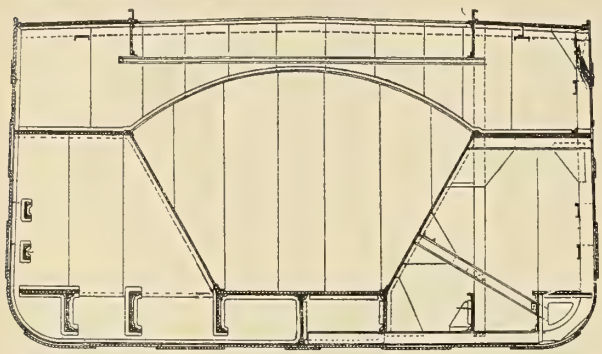
753,948. INSTRUMENT FOR TAKING SOUNDINGS. EUSTACE E. WIGZELL, LONDON, ENGLAND. Four claims.

754,054. SUBMARINE PRESERVING AND ANTIFOULING COMPOSITION. MATTHEW H. DEVEY, PHILADELPHIA, PA. FILED DEC. 5, 1901. RENEWED JAN. 11, 1904. SERIAL NO. 188,666.

Claim.—1. A compound consisting of boiled linseed-oil, litharge, sulfate of copper, Venice turpentine, Portland cement, and ground glass. Three claims.

754,107. SHIP CONSTRUCTION. AUGUSTUS B. WOLVIN, DULUTH, MINN.

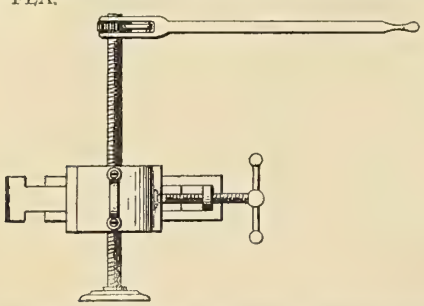
Claim.—1. A steel ship having an unobstructed trough-shaped cargo-hold, which is located midway between the sides of the ship, and which has a floor which does not extend as close to the sides as do the hatchways, and which has outwardly-flaring side walls extending from the floor to the main-deck.



2. A steel ship having a plurality of keelsons, a floor laid thereon, a shelf-like main-deck extending inward from the sides of the ship, and longitudinally-extended partitions which are inclined outwardly from the floor to the edges of said main-deck.

3. In a ship construction, the combination with a hull, of side frames, and a plurality of keelsons, vertical stanchions, main-deck beams secured to said stanchions and side frames, a floor secured upon the keelsons and longitudinally-extended partitions which are outwardly inclined from the floor to the inner edges of said main-deck, and are located wholly between the stanchions and the centre of the ship. Three claims.

754,115. SHIP-BUILDER'S CLAMP. NEWTON C. BAILEY, TAMPA, FLA.



Claim.—1. In a clamp, a block having a screw-threaded bore, a jaw rigidly mounted on said block, a jaw slidably mounted on the block, an ear on said jaw, a screw-rod mounted in a screw-threaded bore in said ear and journaled in the block, and a screw-plunger intermembering with the screw-threaded bore in the block, having a plunger-head on one end and an actuating means on the other end. Two claims.

754,222. BALLAST-COMPARTMENT FOR SUBMARINE BOATS. SIMON LAKE, BRIDGEPORT, CONN.

Claim.—1. In a submarine boat, the combination with a water-ballast compartment and means for controlling its fluid contents, of a movable partition fitted to said ballast-compartment and acting idly in respect of the said controlling means to adjust the capacity of that portion of said compartment containing the water ballast to correspond with the volume of its fluid contents. Five claims.

754,464. SIGHTING OR OBSERVING TUBE FOR VESSELS. SIMON LAKE, BRIDGEPORT, CONN.

Claim.—1. The combination with a vessel, of a sighting-tube having in its upper or outer end a reflector movably mounted therein for receiving and reflecting inwardly an image of an external object, and means connected with said reflector and automatically controlled independently of the trim of the vessel for maintaining said reflector trained toward external objects at the level of the water. Five claims.

754,611. SUBMARINE DREDGING AND SLUICING DEVICE. ROBERT G. RILEY, SEATTLE, WASH. One claim.

754,620. VALVE-GEARING FOR STEAM-ENGINES. JAMES B. STANWOOD, CINCINNATI, O. Five claims.

754,710. PROPELLING APPARATUS FOR VESSELS. MARX P. SCHETZEL, OAKLAND, CAL. One claim.

755,064. APPARATUS FOR DISCHARGING LOOSE CARGO FROM VESSELS. HARRY SHOOSMITH, ORMISTON, ERITH, ENGLAND.

Claim.—1. For facilitating the discharge of loose cargo, a navigable vessel having a cargo-discharge opening through the lower portion of its hull, a water-tight door secured to said vessel and adapted to close said opening, a supplementary door secured to said vessel inside said water-tight door, said two doors being independently attached and supported, whereby the weight of the loose cargo on the inner door will not be transmitted to the outer water-tight door.

2. For facilitating the discharge of loose cargo, a navigable vessel having cargo-discharge openings through the lower portion of its hull, water-tight doors hinged at one side to said vessel so as to open outward, hinge-bolts attached to said vessel and adapted to hold said doors in a positioon to close said openings in a water-tight manner, and supplementary doors hinged to said vessel at the inner portion of said openings and arranged to open outward. Two claims.

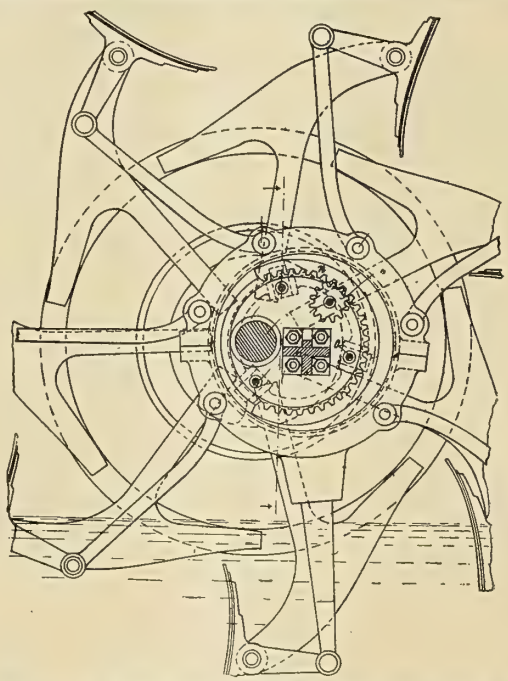
755,241. LIFE-BOAT-LAUNCHING APPARATUS. WILBUR F. POWERS, CAMDEN, N. J.

Claim.—1. In a life-boat-launching apparatus, the combination with davits hinged to swing outwardly, of a pair of racks mounted to reciprocate in suitable ways parallel with the planes of oscillation of the davits, motor mechanism for positively actuating said racks, co-operating cables and paying-out mechanism automatically and positively operated simultaneously with the movement of the racks. Five claims.

755,536. APPARATUS FOR RAISING OR SINKING VESSELS IN LOCK-CHAMBERS. FERDINAND POKORNY, MORAVSKA OSTRAVA, AUSTRIA-HUNGARY. Four claims.

755,426. PROPELLER. JEROME I. WOOD, PHILADELPHIA, PA. One claim.

754,991. PADDLE-WHEEL FOR VESSELS. ERNST H. H. GOTTLEBE, MAGDEBURG, GERMANY.



Claim.—1. A paddle-wheel with adjustable angle-paddles comprising a rotary shaft, an eccentric surrounding said shaft, an eccentric-ring on said eccentric, an outer eccentric-ring, blade-carrying levers mounted on said outer eccentric-ring and means for partly rotating the inner eccentric-ring relatively to the eccentric. Three claims.

Electric Units.—An interesting paper on the subject of electric units will be introduced at the St. Louis exhibition to the congress of electricians by an Austrian civil engineer and specialist in electrotechnic. This paper will be based on a new unit of time replacing that of the second, in accordance with a new division of the circle (angles). A year ago Dr. Gino Dompieri published in German a pamphlet on the subject, which was favorably commented on by the Continental press. An abridged version of this pamphlet may be obtained in English adapted to American readers.

Wrecks and Casualties for February.—The Administration of the Bureau Veritas, Internation Registry of Shipping, has just published the list of marine disasters reported during the month of February, 1904, as follows: There were 61 sailing vessels lost from various causes, 29 of which were from stranding, 5 from collision, 12 condemned, 7 abandoned, 4 foundered, 3 missing, and 1 from fire. Of this total, 20 sailed under the American flag. Of the steamers, 10 were lost from stranding, 6 from collision, 3 foundered, 5 condemned and 2 abandoned.